MODERN X-RAY PRACTICE

AND

CHIROPRACTIC SPINOGRAPHY

REMIER

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Milo Gene Bennet
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Modern X-ray Practice
and
Chiropractic Spinography

BY

P. A. REMIER, D.C., Ph.C.
SPINOGRAPH ANALYST

Professor and Lecturer
of
Spinography and X-ray Practice
The Palmer School of Chiropractic
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Practical treatise of modern X-ray practice and principle covering all branches of radiography of the human body.

Machine operation, placement, technique, darkroom and developing practice, preparation of patient, dental radiography and all safe procedures dealt with in X-ray work.

Davenport, Iowa
U. S. A.

A Tribute

To those living who so gallantly and faithfully
are fighting to their very end
And to the martyrs of this great science who
sleep in shrines of honor and inspiration,
Do I pay my deepest and most sincere respects.

Dedication

●

Inasmuch as Chiropractic Spinography and its founder and developer met with the same barrage of criticism and misunderstanding which all other new ideas and their authors have, I think it very fitting and proper to dedicate this text to Dr. B. J. Palmer, the developer of Chiropractic.

The Genius

They could not understand him—he was one
Who walked on fire when others trod the clay,
Who followed mountain glimmers far away,
Or like an Eagle soared into the sun.
They could not understand him — there were none
Who roamed the highlands where he loved to stray,
Though, far below, the throng would snarl and bray,
Watching him mount where rainbow mists are spun.

And yet when at last, reviled and scorned, he died,
His name was set in gold and Deified,
Symbol for weeping millions to adore;
But still from cloud and crag he gleamed alone,
And still men praised him as a god unknown,
And understood no better than before.

— Stanton Coblentz

Preface

HERE the author has attempted to organize in a manner, as clearly as possible, all the new Stereoscopic technic and procedure in Chiropractic Spinography which has been worked out in the X-ray Laboratories of the Palmer School of Chiropractic. Also other definite X-ray procedures in the various phases of X-ray and Spinography are included.

The information contained herein is based on the actual results obtained after many years of extensive scientific research and experimentation, involving the use of many thousands of films and cases.

Though this present volume carries the student of Chiropractic Spinography forward into the Atlas-Axis specific Stereoscopic field it also dips back for clarity's sake into the former period of general adjusting, so that this work will be found of value to all—no matter upon which step of Chiropractic progress they find themselves.

With this in mind it is anticipated that the knowledge contained herein will be of value to all Chiropractors and to all Spinographic X-ray Laboratories.

Such technical information and Stereoscopic procedures should greatly assist the profession in its work. And if its contents contribute to an improved quality in the analytical value of all spinographs it will then have fulfilled its mission.

Acknowledgments

The author wishes to acknowledge at this time his sincere appreciation to the P. S. C. faculty for their help and encouragement in the publication of this text.

Drs. B.J. and Mabel Palmer have permitted me to proceed in my field almost at will, and their interest in my efforts has been very stimulating. For all this I am truly grateful.

The author also desires to express gratitude and appreciation to his co-partner, Dr. Lyle Sherman for his sincerity, ability, untiring efforts, and valuable service in the preparation and production of this book.

To Dr. Hugh McIntyre of New Zealand for his valuable help and suggestions in this work I am likewise indebted.

To Otto Schiernbeck, Otto Schweinberger, Loyal and Paul Worden for their valuable assistance in preparing the electrical knowledge supplied here.

To Dr. John Pickles of Australia, Albert Collins of Detroit and Henry Doody of New York for their interest in submitting the drawings from which etchings were made I am also indebted. They assisted as only true friends could.

To Drs. Kurth, O'Brien, Riesterer and Mae B. Ferguson of the Spinograph Department for their most valuable service in the preparation and correction of the material for this book I also extend a word of appreciation.

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Introduction

HISTORY of the X-ray dates back to the latter part of the nineteenth century. Since that time it has indeed been a struggle. Perhaps the first X-rays were produced by Crookes in 1875, while experimenting with a vacuum tube, although similar experimentations were carried on by Geissler in 1858. Then Professor Hittoff, about the year 1860, discovered that the luminous stream of electrical discharges in the Geissler tube could be deflected by a magnet. This fact had an important bearing upon the experimentations made by Crookes, Hertz, Leonard and many others.

The work of Geissler and Hittoff was followed, several years later, by the experiments of Crookes with high vacuum tubes. Using these high vacuum tubes he found that the luminous glow would disappear. This demonstrated that with such a type of tube there was a rectilineal radiation from the cathode which was a projection of particles of highly attenuated gasses at exceedingly high velocity. This rectilineal radiation he called the cathode rays or stream.

In 1892 Hertz and Leonard, experimenting with vacuum tubes and their cathode rays, found that the radiation from these vacuum tubes would pass through or penetrate many substances opaque to ordinary light. Also it would excite and fluoresce in crystals of platinobarium cyanide and so effect photographic plates.

In 1895 Professor William Konrad Roentgen, then Professor of Physics at the Royal University of Wurzburg, Germany, began experimenting with the Crookes tube. Investigations proved that the fluorescence was caused by the radiation which was emanated from the point of impact of the cathode rays against the wall of the vacuum tube. He further noticed that this radiation could neither be refracted

PLAN OF MODEL CHIROPRACTIC OFFICE

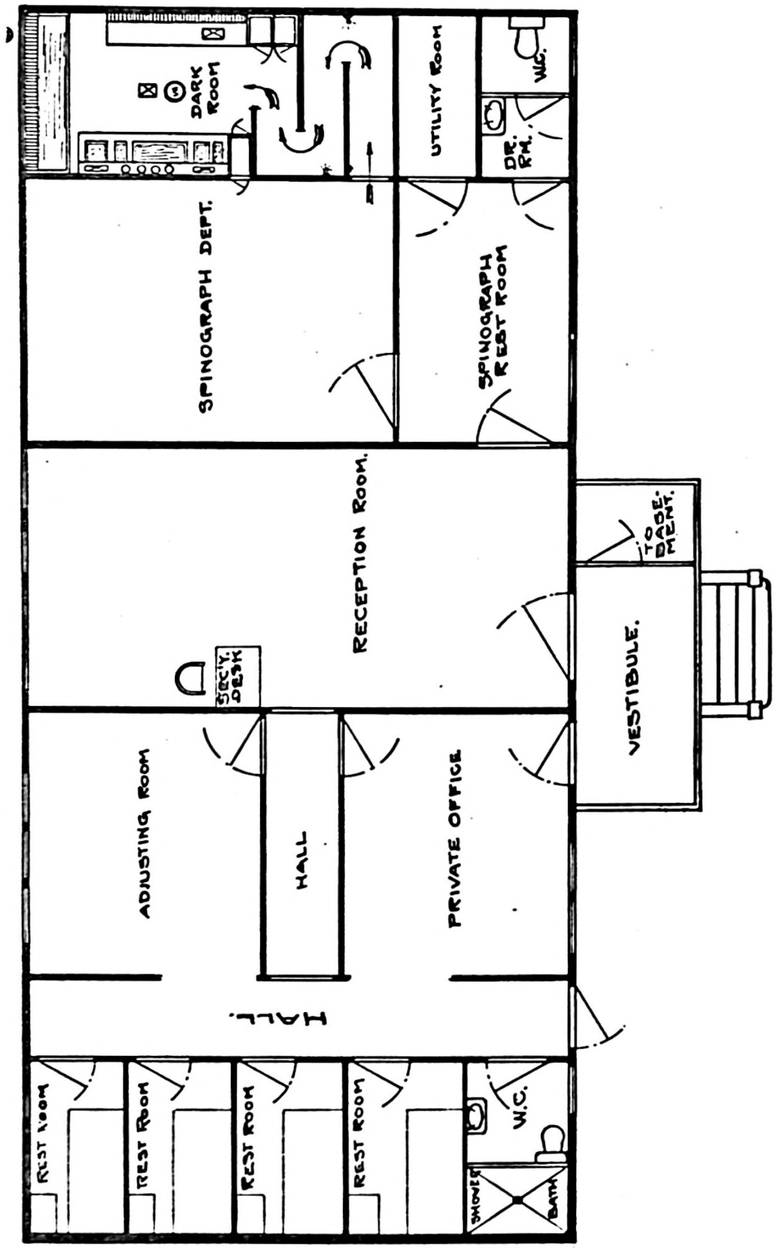


Figure No. 1

nor reflected to any extent and that it was not deflected by a magnet. Hence, it was obvious to him that this radiation was different from the cathode rays of Crookes. He called these rays "X" rays, probably because of the significance of the letter "X" in the mathematical formula. Using photographic plates protected from ordinary light, Roentgen was then able to obtain with the X-rays, shadow pictures of metallic objects.

In 1895 he communicated his discovery to the Physical Medical Society of Wurzburg, Germany. This communication was immediately published all over the world. The same year that Professor Roentgen discovered the X-rays, D. D. Palmer discovered Chiropractic.

The author at this time wishes to take the liberty to wander back through the years of 1905-06 when he personally became somewhat acquainted with X-ray procedure. At that time more concern was being taken with the darkroom end. Having some boyish photographical and electrical knowledge and being of a somewhat mechanical mind I was permitted to tinker with an X-ray machine and later develop X-ray plates for a medical man. I was then employed in a photographical establishment at nights after school and Saturdays. The actual picture taking, I of course did not do. But how well I remember the type of X-ray machine and how I now appreciate our modern equipment of today.

Machines of that day were of the static type with gas tubes which one had to coax along, so to speak, by continually engaging and disengaging the X-ray switch. Thus one attempted to force through the tube a certain amount of current until its resistance was such that a specified amount of current would pass through the tube. This procedure was usually a tedious one and even then one could not be certain of the correct amount of current used. Naturally the quality of pictures was not the best.

At that time machines were very noisy when the current was passing from one terminal to another. X-ray work then practically consisted of fluoroscopic examination, and ex-

tremity work. Occasionally the hand fluoroscope was used, but nothing had been done with spines or deep tissue.

Glass plates were used. The emulsion was placed on only one side which was the one of course to receive the exposure. The Doctor determined the emulsion side, while in the dark-room, by wetting his finger and touching either side of the plate at the extreme corner. The emulsion side would be sticky. Then under the safelight the plate was returned to its black wrapping paper and placed in a cardboard holder for exposure procedure. The operator, of course, kept the plate from being fogged by ordinary light. Also one had to be very careful not to break the plate during the developing process, as a matter of fact, during the exposure as well. The tray system was used and plates submerged with the emulsion side up. Then a tuft of cotton, saturated in the developer, was lightly carried over the emulsion side to hasten the actual development.

As time passed, more efficient equipment was constructed and so a better quality film produced. Soon instead of glass plates came the X-ray film with its transparent base which used the emulsion on both sides. To further increase the speed of the film and to add contrast and detail an intensifying screen was constructed. Later two screens were employed, each being placed in a cardboard holder which was backed with a thin sheet of lead foil.

Then came the cassettes in which the two screens adhered to the inside face and cover. And so today our exposures are made more or less instantaneously and both detail and contrast prevails throughout.

In 1910 X-rays were introduced in the Chiropractic profession by means of the Spinograph, that is a shadow-graph of the spinal column. Perhaps this profession was the first to ever X-ray the spine or the spinal column, with any results at least. The word Spinograph was coined by Dr. B. J. Palmer, the Developer of Chiropractic.

From that time hence Chiropractic and Spinography, as a science, has been steadily increasing. Each year finds the

Palmer School of Chiropractic carrying on more and more scientific research.

During the spring of 1930, Dr. B. J. Palmer discovered the Atlas and Axis specific theory and during the fall of that same year this theory became a working principle.

By the spring of 1934, great progress was made in Stereoscopic Spinographic research and experimentation. Twelve months later definite conclusions were reached in regard to the Atlas rotation. Sufficient depth, produced by the peculiar manner of procedure, made third dimension pictures whereby it was obvious that the rotation of the Atlas did actually exist. This created the demand for more accurate cervical X-ray views and to satisfy this demand X-ray facilities were greatly improved.

With the advent of specific work came the demand made for Spinographic views taken before an adjustment with subluxation and after an adjustment without subluxation and then with the intermediate check sets of Spinographs so it became necessary to have a posture, as near constant as possible, which was fundamental and to have all Spinographic sets of the same person taken exactly alike.

1935 Rotation of Atlas definitely established.

Dr. B. J. Palmer not only saw the necessity for such scientific equipment but also proceeded to make such equipment that would facilitate the making of Spinographs and Spinographic Stereoscopic X-rays. By this equipment he felt that accuracy and precision in revealing the exacting natures of the shifting of positions of subluxations following an adjustment would be attained.

Thus the desires of this ingenious, inventive and untiring mind not only created the demand for this scientific research but also caused its scientific exacting precision equipment to be developed and in this development he spared neither time nor money.

1937 Vertex procedures became a working principle.

Today his X-ray Laboratories and his Clinic are equipped with the most modern complete Spinographic and Stereo-

scopic Chiropractic X-ray units, with accessories available. They represent the Utopia of Chiropractic X-ray equipment and as much can be said for his equipment as can be said for him as a man among men — he, B. J., the developer and leader of our great profession.

X-RAY PHYSICS

The general scientific research during the latter part of the nineteenth century seemed to be the search for invisible light rays. And so it was towards this end that all such scientists as Geissler, Crookes, Hertz and his assistant Leonard, Roentgen and many others were working.

Geissler constructed a glass tube from which he eliminated much of the gaseous atmosphere. Then he found that when he connected both ends of the glass tube with the proper amount of electrical current, it would light up — giving off a sort of apple-green fluorescence. He explained this light as follows — that the passing of the current through the tube caused the molecules of gas to combat, breaking them up into even smaller particles which were called atoms and electrons.

Crookes, experimenting with the Geissler tube, constructed another tube of even higher evacuation. He observed a rather purple-colored stream when the current was induced, from the cathode to the anode or target end of tube. He also noted that intense heat was produced at the anode end of the tube upon the impact of this colored stream, which he called the cathode stream or ray because it came into existence at that point. So due credit goes to Hertz and Leonard, although Hertz died and his assistant, Leonard carried on this research.

In 1895 Professor William Konrad Roentgen of Wurzburg, Germany, while experimenting with cardboard or some other base coated with platinol and barium cyanide, noticed that when the current was passed off and on through the glass tube this prepared solution on its base fluoresced and dark shadows became visible. Further experimentation proved that under certain conditions on this so-called screen a

shadow outline of the bony parts of his hand and a lesser shadow of the flesh could be observed.

It was then that he named these rays "X" rays because of its significance to the letter X in the mathematical formula. His discovery was then published and communicated all over the world, and the Physical Medical Society further honored him by naming these rays "roentgen rays".

Although new ideas have been discovered and many changes have been made in the apparatus used in the production of X-rays, the actual laws pertaining to their production remain as Professor Roentgen found them.

X-rays may be described as extremely short wave lengths in ether, produced by an electrical current passing through a glass walled vacuum tube. They travel only in straight lines from the point of impact on the target. They can neither be deflected by a magnet, reflected by a mirror, nor refracted or polarized as our light waves, however this radiation does have some similar analogy.

The production of X-rays in the vacuum tube is the result of the projection of minute electrical particles, known as electrons, that are given off by the heated tungsten filament from the cathode to the anode or target end of the tube. X-rays travel in all directions from their point of origin except where dense material obstructs, absorbs, or prevents their passage. A one-sixteenth inch of virgin sheet lead will absorb X-rays or radiographic energy. The same amount of energy will penetrate through a one and one-half foot of plaster wall or ten feet and even more. On the other hand one and one-half feet of concrete wall seems to be opaque to the ordinary radiographic rays.

When passing through bodies made up of different densities some of the rays that enter the denser portions are perhaps permanently cut out and a new distribution of intensity in the path results.

The wave length of the X-ray depends upon the amount of voltage supplied at either end of the tube. The greater the voltage, the shorter the wave length, and the lower the volt-

age, the longer the wave length. This is commonly spoken of as hard and soft tube radiation.

The speed of the X-ray is said to be the same as that of the light ray—186,330 miles per second. The speed of the X-ray does not imply that it will travel great distances since its penetrative value also depends upon its wave length. The more resistance offered, the shorter the wave length must be. The presence of X-ray is only determined by the effects produced on a photographic emulsion and its ability to make certain chemicals or crystals fluoresce. On the fluoroscopic screen, dense bodies are shown as dark areas while on a photographic or X-ray negative they are revealed as light areas.

Various investigations have revealed that X-rays are identical in their nature with light and electric waves except that their wave lengths are much shorter than even the shortest light wave. Due to this extremely short length, their effect on matter upon propagation is quite different from that in the case of longer waves. Short waves are produced only by a change in the velocity of electrons taking place in intervals of time too short to be easily conceived.

In the production of X-ray there are four problems to consider:

1. To segregate electrons from atoms.
2. To give high speed.
3. To condense them on a small area.
4. To stop them with sufficient suddenness.

The Gamma rays of radium are simply rays due to the sudden expulsion of electrons by the atomic break down. They may be shorter or even longer than radiographic X-rays.

About the year 1900 Madame Curie found, when analyzing radium, that there were three separate and distinct rays present: the Gamma, Alpha and Beta rays.

The term "ray" is used to designate two distinct types of phenomena. One refers to a projection of small particles by atomic disintegration as that of the Beta and the Alpha

rays. The other refers to the transfer of physical effects by the agency of wave motion such as light, Gamma and X-rays.

The other refers to the transfer of physical effects by the agency of wave motion such as light, Gamma and X-rays.

Gamma rays are similar to X-rays in physical nature except that some Gamma rays are of shorter wave lengths. The Alpha rays are known as the positive atoms—the Beta ray as the native.

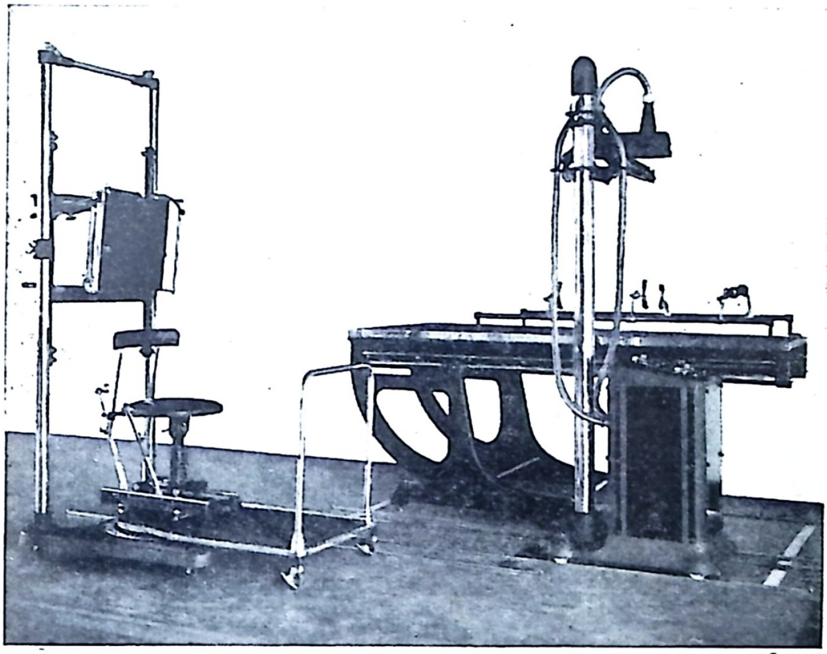


Figure 2
X-ray machine, with vertical cassette holder bucky diaphragm and turntable for sitting upright posture and tilt table for prone, supine or upright X-rays

Science tells us that matter is composed of molecules and that molecules are composed of atoms and that atoms are composed of electrons.

These tiny, minute, electronic particles are sometimes spoken of as the cathode or Beta rays because they are a negative charge and attain an extremely high speed or velocity while the atoms themselves are a positive charge.

CHAPTER 1
ELECTRICAL AND SPINOGRAPHIC TERMINOLOGY
MACHINE

Aerial—often spoken of as an over-head aerial. It usually consists of three lengths of approximately ½″ copper tubing, suspended from the ceiling and directly or indirectly contacting the rectifier.

Alternating (AC) Current—is that which varies in sign and progresses through both positive and negative terminals. In other words, it reverses its direction periodically or within every cycle.

Automatic Hand Timer—is a device whereby the exposure time may be accurately controlled and X-ray exposures duplicated. This device usually operates in fractions, from 0 to 12 or 15 seconds.

Bucky Release Button — Modern up-to-date X-ray machines and Bucky Diaphragms are equipped with an automatic magnetic release. By making the proper control setting on the working panel and cocking the grid within the Bucky Diaphragm, one may press the release button on the panel and the grid automatically starts. In about 1½ seconds the production of X-rays begin, then stop or exposure time is finished, and in 1½ seconds the grid stops. Note the grid travels the same distance at the end of the exposure as it does at the beginning of the exposure.

Circuit—is the complete path of an electrical installation.

Circuit Breaker—is an automatic device which will automatically cut out an over-load to the tube. It is a safety device and all machines should be supplied with one.

Conductor — any substance over or through which the electrical current travels, such as: brass, iron, steel, water, and certain types of wood—particularly wood that has a great deal of pitch in it.

Current Direction Through the Tube — from Cathode to Anode.

Cycle—is the complete travel of the alternating current through its positive and negative valves. The ordinary com-

mercial AC current ranges from 25 - 60 cycles. Practically all X-ray machines are constructed to operate on such a type of current.

Direct (DC) Current—is that which does not vary in sign or current and which flows or travels in the same direction at all times, from positive to negative terminals. There are comparatively few localities in the United States where only Direct Current is supplied; whereas, in foreign countries, it is said Direct Current prevails.

Filament Control—is a device, finely graduated, by which the technician may determine and regulate the amount of current passing through the X-ray tube.

Filter—refers to a piece of aluminum 1 mm. thick and approximately 5″ square. Its purpose is to absorb the soft rays which are the longer wave length or X-rays of little penetrative value. These rays are injurious to the patient.

Foot Switch — is made to operate by foot pedal or the push-button. It connects, in the line, with the X-ray switch on the working panel of the machine. It may also be constructed to operate as a Bucky Release switch. This perhaps offers a more convenient method of operation.

Fuse—is a soft piece of metal alloy wire—in the circuit for protection from any abnormal over-load. It may be said to be a safety measure in the circuit, as it will melt or break under abnormal conditions.

Galvanometer—a sensitive instrument used to detect the presence or absence of an electrical current which also measures a small quantity of current.

Ground—From the X-ray standpoint this refers to a wire connection between the equipment and a water or gas pipe that is actually buried in the earth somewhere along the line. This is for the purpose of carrying off the static electricity which the patient would ordinarily feel during the X-ray exposure. Of course, the static would not injure the patient, so far as a shock is concerned, but would cause him to move more or less which would give the object a blurred and fuzzy appearance on the film. Such a film would be of little value, and would have to be retaken

High-Tension Transformer—also called step-up or main transformer, increases the primary voltage to a greater capacity. It consists of an insulated iron box and coils with numerous turns of wire. All this is immersed in a high grade of transformer oil.

Inverse—in the tube refers to the current travel in the wrong direction. This, many times, has punctured a tube or may produce a gaseous one.

Line Drop—refers to the drop in primary or line voltage supplied to the machine. It may be the result of too small size in gauge of wire, the length of run wire from transformer to machine, capacity transformer or other loads taken from the same transformer. Ice machines, elevators, etc. often cause line droppage.

Low-Tension or Step-down Transformer — An electrical device which reduces the line voltage for heating the filament wire in the tube. The terminal voltage ranges from 5 to 12 volts.

Mechanical or High-Tension Rectifier—constructed in two types, cross arm and the disc type. Its purpose is to change the AC current leaving the step-up transformer to a pulsating directional current. It is only necessary when operating machines having a greater capacity than 90 KVP and 30 M.A. With units having a lesser capacity the tube makes its own rectification.

Milliampere Meter — is a device by which one may determine the amount of milliamperes to the tube. In the larger units where an overhead aerial is used such a meter is placed within the overhead aerial while in smaller units having no such aerial, the milliampere meter is installed on the control panel of the machine.

Motor Switch—usually a small push or pull button on the working panel of the machine. It cuts in the motor and revolves the rectifier and when using modern up-to-date equipment it also automatically determines the polarity. When using equipment not up to date the first pull or push on the motor switch, the polarity indicator may point the wrong direction. Then it is only a matter of stopping the

motor and restarting until the indicator points in the proper direction.

Non-Conductor—is any material, over or through which, the electrical current will not travel, such as glass, rubber, and certain types of wood—particularly wood that is seasoned having little or no pitch in it.

Non-Shock Proof Unit—is an X-ray machine having bare or uninsulated wires from the high-tension transformer to either end of the X-ray tube. In this type of machine the tube is not usually incased.

Polarity Indicator — shows the direction of the flow of the current to the X-ray tube.

Pre-Reading Volt Meter—Such a meter is connected on the low-tension side of the auto-transformer circuit and measures the voltage from each tap of the auto-transformer to the main transformer. In this manner various KVP may be actually determined and duplicated.

Reels—are fastened to the over-head aerial or to the mast of the machine and make connection indirectly from the transformer to either end of the tube. With up-to-date equipment these reels are usually eliminated and the wires are heavily insulated and are known as shock-proof cables. This refers to shock-proof equipment. The double reel attaches to the negative end of the tube while the single reel attaches to the positive.

Remote Control Panel — is a control which is separate from the tube stand and which can be moved about, or operated, in a separate room.

Rheostat—is an electrical device made up of a number of turns or coils of resistant wire for the purpose of offering resistance. It is placed on one side of the line between the auto-transformer and step-up or the high-tension transformer.

Shock-Proof Unit — is one having insulated wiring or shock-proof cables from the high-tension transformer to either end of the X-ray tube. In this type of X-ray machine the tube is usually incased or immersed in oil.

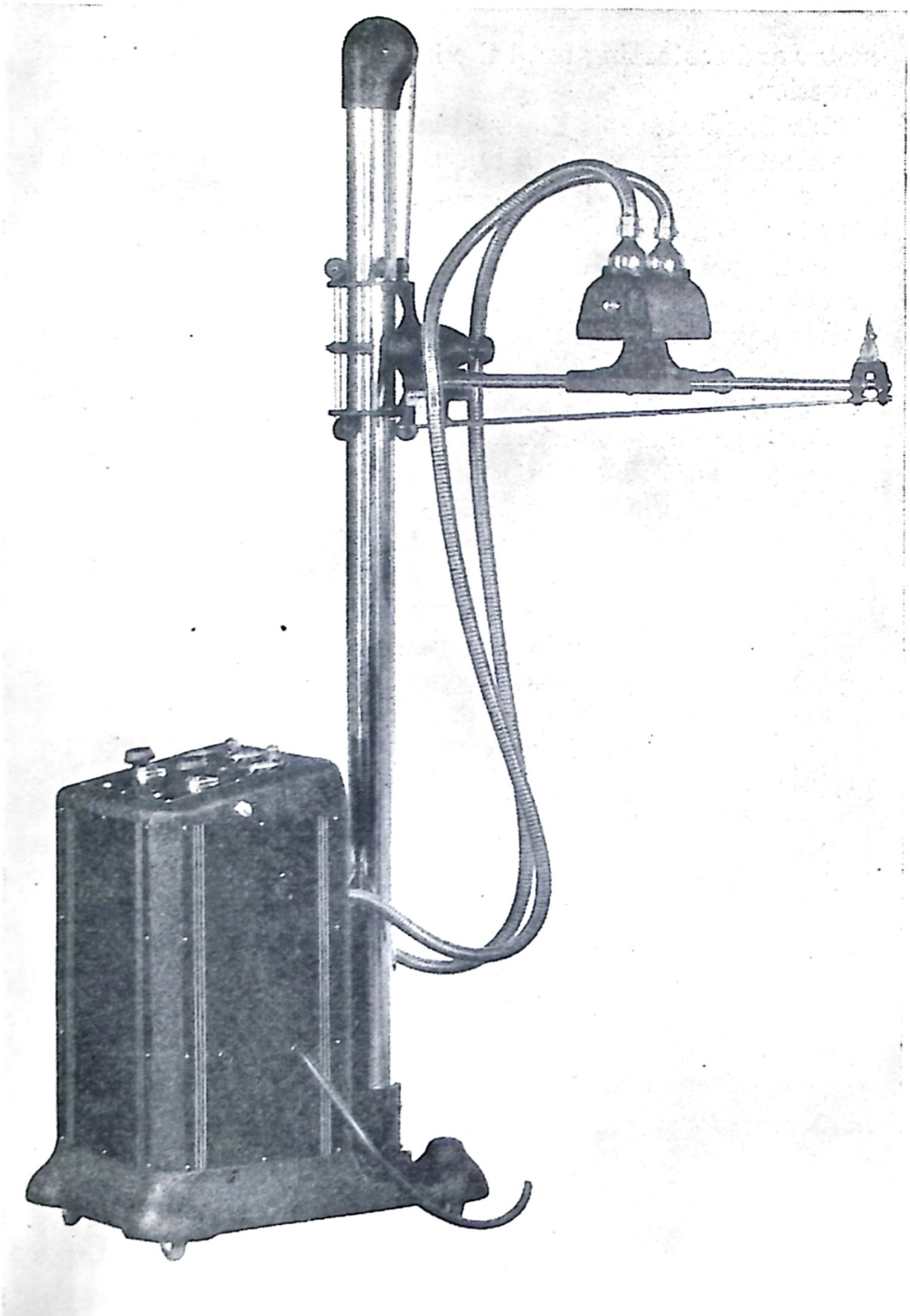


Figure No. 3
Models S and T (Spinograph) Shock Proof Units 5-30 and 60-88 Capacity

Spark-gap or Back-up—refers to an old method by which one may determine the amount of KVP used in the making of any X-ray negative.

Static Electricity — current at rest — ideal, neither dynamic nor in motion.

Surge—means a rapid change in the voltage which may, or may not, be read upon the pre-reading volt meter. Such a condition may be the result of a high resistance, live circuit and a heavy, rapid application of a load. A faulty rectifying switch or a ground leakage in the high tension circuit usually explains this condition.

Synchronous Motor—is one, timed exactly with the frequency of the alternating current. Its purpose is to revolve the high-tension rectifier.

Uni-Directional Pulsating Current — is rectified from alternating current by means of either a mechanical rectifier, valve rectification or through the tube itself. The radiographic machines used today are the mechanical rectifying type, self-rectification and valve rectification. The latter consists of two types, one valve half wave, four valves full wave.

X-ray Control Panel—sometimes referred to as the working panel. However, it is the section of the machine with dials and switches which is manipulated manually to produce a certain setting or given technic.

EQUIPMENT AND ACCESSORIES

Barium Meal—is a powder substance mixed with a liquid and taken internally. This meal will adhere to the walls of the stomach and intestinal tract offering sufficient opaqueness to reveal on the film contours and certain lines of demarcation. It is also used in fluoroscopic examinations.

Bucky Diaphragm — made in either the curved or flat types. The flat is more universally used. Its purpose is to eliminate secondary radiation which is very detrimental to the X-ray film. It might be said that its main parts are the

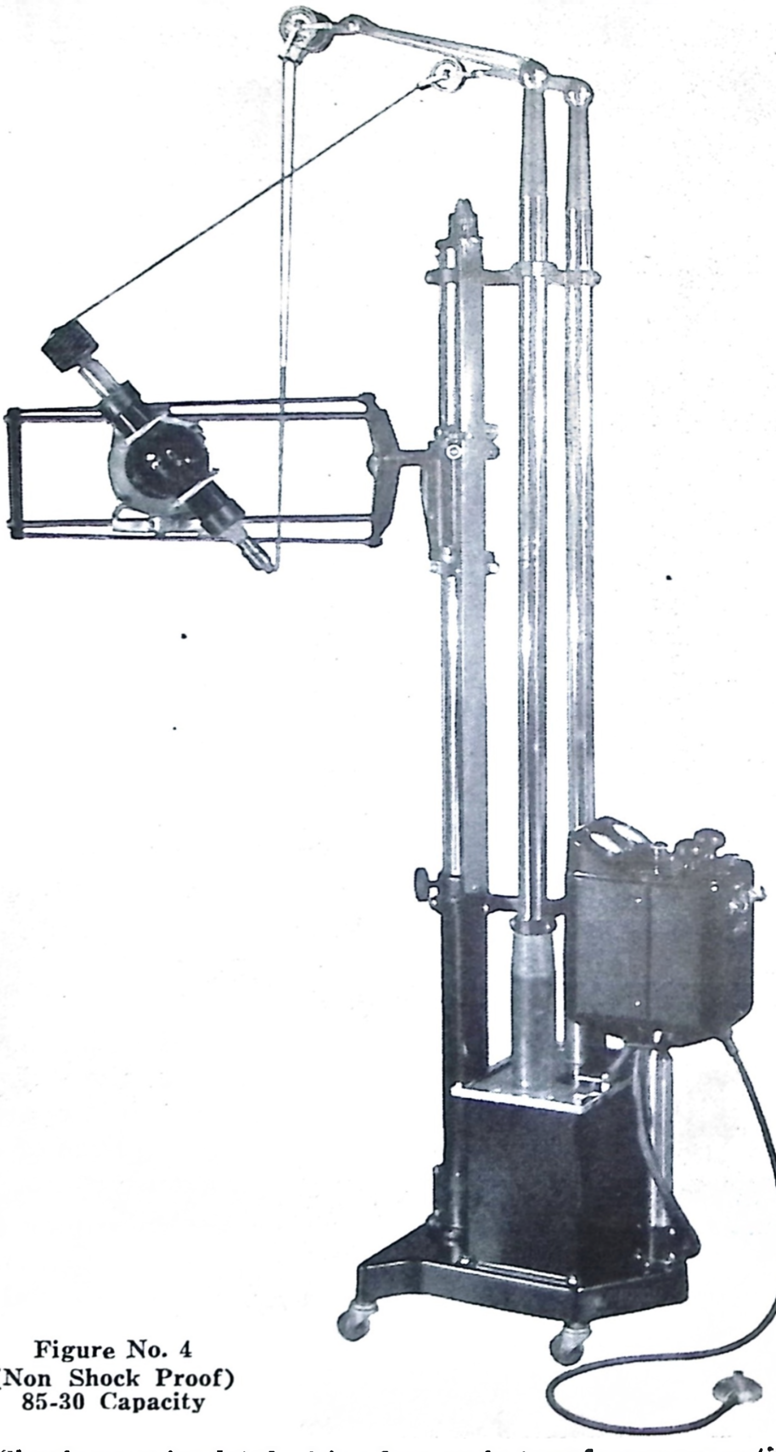


Figure No. 4
(Non Shock Proof)
85-30 Capacity

Showing non-insulated wiring from main transformer connections through reels to either end of the tube.

movable grid and the device for synchronizing the moving grid with the actual exposure time.

Bucky Grid, referred to as a Movable Grid—is one of the main parts of the Bucky Diaphragm. It consists of a frame which holds thin strips of lead and certain types of wood. Its purpose is to absorb a greater amount of the angling and secondary radiation. With proper alignment and correct procedures the lead strips will not appear on the developed film as grid lines.

Cassettes—a light proof metal holder having either an aluminum or bakelite front or face. Such a holder carries the film through the process of exposure, and of course keeps the ordinary light from contacting the film. The idea of the aluminum or bakelite face adds to or decreases respectively the amount of cassette resistance. Cassettes are made in various sizes to accommodate the various areas to be X-rayed.

Developing Hangers — can be had in various sizes to accommodate the various size films. They suspend the film and keep it submerged during the developing process. Such a device also prevents the films from contacting one another during the process.

Fluoroscopic Screens—may be had in either the standard or hand types. When such screens are excited by X-rays they fluoresce or produce a luminous glow when all ordinary light in the room is excluded. Such screens are for the purpose of examining the movable parts of anatomy to aid in reducing fractures and for locating foreign bodies.

Illuminators—boxes made single or double with an opal blue glass front. They contain 75 Watt blue bulbs or fluorescent lighting. The purpose of these illuminators is to produce the proper intensity to facilitate the analyzing of the finished X-ray negative.

Intensifying Screens—are of various speeds and used in all types and sizes of cassettes for the purpose of adding detail and contrast to the film and also to shorten the actual exposure time.

Lead Cabinet—is an absolute necessity in X-ray laboratory equipment. It will absorb all secondary radiation. This would ordinarily fog the unexposed film and give the finished film a muddy, not contrasty appearance. Such films would be of little analytical value.

Leaded Glass Goggles — refers to goggles worn during fluoroscopic examinations for the purpose of protecting the operator's eyes. Such leaded glass goggles have the equivalent of 1-16″ of sheet lead.

Lead-lined Apron and Gauntlets—These accessories have the same equivalent of lead and protect the operator's hands and body.

Stationary Grid—Its purpose is to eliminate secondary rays and produce clearer films. The principle is similar to the Bucky Grid. It produces good results and is more or less popular throughout the profession.

Protection Booth and Screen—Such a booth is lead-lined and absorbs all secondary rays. This absolutely protects the operator. The screen also lead-lined, offers approximately 1-5 protection and absorbs only rays from one side.

Stereoscope — a device for seeing depth on the Stereoscopic X-ray film.

Turn Table—a unit to manually rotate patient's body, has an adjustable seat attached, made to fit the crescent base of the Vertical Cassette Holder. Its purpose is to make possible the precision alignment of the patient, tube, and film.

Vertical Cassette Holder—consists of an adjustable seat arrangement whereby the Bucky Diaphragm or film itself may be adjusted to most any conceivable angle. It may be operated stationary or moved about on a suitable track

Virgin Sheet Lead—is pure lead with no tin in it. Pure lead should always be used as a means of protection. Secondary rays and ordinary radiographic X-rays will not pentrate 1-16″ of sheet lead.

Wall Switch—a safety switch box connecting outside or incoming electrical line with cable leading to X-ray machine.

X-ray Cone — constructed of either lead or leaded-glass having the equivalent of 1-16" of sheet lead. Its purpose is to reduce the radiographic field and add to the elimination of secondary radiation.

X-ray Films — X-ray negatives with double, highly sensitive emulsion.

X-ray Fog—refers to certain abnormal conditions appearing on the developed film. These may be due to secondary rays, ordinary light, developer or hypo stains, etc.

X-ray Markers—usually made up of lead letters and numerals for the purpose of determining the right and left side of the patient, right or left stereo shift. Also used to connect the patient's name, date, and name of the laboratory with the film. All this is X-rayed or embedded in the film and is a necessary requirement in legal action.

TECHNIC

Ampere—is a unit of current flow and is determined by an ampere meter. It is used commercially to measure the amount of current for lighting purpose and for power work. It measures the current delivered to the filament of the X-ray tube.

Angling Rays—are those driven from an angle off the tube target. They are not as valuable, inasmuch as they may cause more secondary radiation and produce distortion.

Complete Dosage—is the maximum amount of electrical current measured in terms of milliampere seconds to which the patient is exposed while under X-ray treatment.

Current in Amperes—EMF in volts, divided by current in amperes.

Direct Rays—are the rays directed approximately downward from the tube's target. They are the most valuable.

Dosage—refers to the X-ray technic used in the X-ray treatment work.

Electro-Motive Force—is the voltage or potential.

Hard Tube Technic—refers to a lesser amount of exposure time with greater penetration or more KVP. Such technic proceeds more instantaneously. Though perhaps a more contrasting film may be obtained with the soft tube technic, such technic does promote motion of the patient on the film. With the hard tube technic naturally motion is more easily eliminated. Motion appearing on any X-ray negative makes the film of little or no value.

Kilo-Volt—is the equivalent of 1000 Volts and is used as a matter of convenience only.

Kilo-Volt Peak—represents the peak of the voltage wave and is measured by a sphere gap. It is called high tension voltage. The term KVP or sometimes spoken of as PKV is indicated on a Kilo-Volt-Peak meter. It provides a method of knowing the amount of penetration necessary in the X-ray work without having to test the X-ray tube each time of operation. This, of course, prolongs the life of the X-ray tube and eliminates a waste of energy. The peak K.V. value is 1.57 times the average value. There are 3 values in AC current.

1—Peak value used in X-ray work.

2—Effective value in commercial work.

3—Average value, seldom used.

Effective value is .707 X peak value.

Average value is .636 X peak value.

Kilo-Watt—is 1000 Watts.

1 Kilo-Watt x 1 hour = 1 Kilo-Watt Hour.

Milliampere—is 1/1000 part of an ampere and also is indicated by a milliampere meter. It is commonly spoken of as M.A. It is simply a finer graduation of measuring the current passing through the tube. The M.A. meter is often designed with two scales. The upper one reads 0 to 30 and the lower one 0 to 100 and even higher. This meter is placed within the overhead aerial or on the working panel of the machine.

Milliampere Seconds — is determined by multiplying the

actual amount of seconds exposure by the number of milliamperes used. This is used as a safety measure or protection for the X-ray patient.

Milliampere Second Limit—is said to be 1200 milliampere seconds for the body, 600 for the head, based on the actual distance from the tube's target to the X-ray film. This limit is used in radiographic work and one should never exceed this at any one time.

Ohm—is a unit of electrical resistance.

Ohms of Resistance—EMF in volts, divided by current in amperes.

Opaque—as applied to X-ray, means any material which does not allow the X-ray to pass through it.

Radiograph—refers to any X-ray negative.

Rectification—There are 3 types; mechanical, self, and valve rectifiers. The latter consists of two types, 1 or 2 and 4 valves. Mechanical rectification is full wave and noisy. Self rectifier means the hot cathode tube rectifies its own current up to a certain unit of heat and is half wave. One or two valves is half wave and four valves full wave rectification.

Secondary Rays—are produced when X-rays meet with resistance. Though traveling in straight lines they often explode and produce more rays. It is from this type of radiation the operator must protect himself.

Scattered Rays—are also referred to as secondary rays.

Stray X-rays are the result of electrons striking the target other than the focal spot. They have no useful purpose and are undesirable. These rays are eliminated by the tube shields.

Skin Distance — refers to the distance from the tube's target to the skin surface of the X-ray patient. This term is used in X-ray treatment work.

Soft Rays—Soft rays are produced when using the soft tube technic. They are rays of little penetrative value and are very injurious to the patient, as they accumulate on the

skin surface, and eventually break down tissue. Soft rays may be partially absorbed before reaching the patient by using a filter of 1 mm. of aluminum or a double thickness of chamois skin, preferably the aluminum filter.

Soft Tube Technic—refers to a technic of a lesser amount of penetration with an extension of exposure time.

Spinograph—a word coined by Dr. B. J. Palmer which refers, Chiropractically, to a shadowgraph of the spine or spinal column.

Tube Distance — refers to the distance from the film to the target of the tube.

Volt — is the method of measuring the charge moving from one place to another. It is known as a unit of pressure or the potential or electro-motive force.

Watt—is the unit of electrical power. It is the product of one ampere x 1 volt, or watts equals volts x amperes. 746 Watts are equivalent to one mechanical horse-power and one Kilo-Watt is therefore equal to about 1⅓ horse-power.

X-rays—or unknown rays are produced upon the impact of the cathode stream against the tube's focal point. They too, travel in straight lines. They are also called Roentgen Rays because of the man who discovered them.

X-ray Burn—is an internal reaction produced by too many X-ray exposures, that is exposures aggregating a sum of milliampere seconds over and above the 1200 milliampere second limit. Such a condition is a serious one, and completely breaks down the tissue.

X-ray Dermatitis—is a superficial condition wherein the X-ray exposures set up a skin inflammation and is quite similar to the X-ray burn but the burn is more serious. Blondes are more susceptible to this condition than brunettes.

Alopecia—refers to the falling out of hair due to too much penetration or exposure time in that area.

Protomeclein Salve and Butesin Picate Salve—have been recommended for the Erythema dose or for X-ray burn.

TUBE

Anode—is the positive terminal or pole.

Cathode—is the negative terminal or pole.

Filament—is in the negative end of the tube. It consists of turns of fine tungsten wire of a high melting point. Its purpose is to furnish electrons.

Target—is a special metal of copper alloy in which the focal point or tungsten button is fastened. This is at the positive end of the tube. The angle of the face of this target varies from 15 to 22 degrees thus allowing the X-rays to be driven downward.

Target Button — is constructed of the hardest known metal (tungsten). It is located on the face of the target, the anode or positive end of the tube, and receives the entire impact of the cathode stream. From then on X-ray becomes a reality.

X-ray Tube—is a sealed glass bowl having a very high vacuum. It has two arms, extending in the opposite directions, having a target sealed in one arm and a filament in the other.

PLATE READING

Ankylosis—Fusing of 2 osseous bodies or points and may be true or false.

Anteriority—refers to an abnormal forward movement of spinal segments.

Anteriority of Atlas — refers to its forward movement which increases the normal space between the odontoid of Axis and the anterior ring of Atlas.

Complete Dislocation—refers to a spinal segment having slipped by both zygapophyses or mammillary processes.

Double Rotatory Scoliosis—an exaggerated rotatory scoliosis combined with a compensatory rotatory scoliosis.

Exostosis — bony growth which may be either true or false.

False Ankylosis—is no more than a rearrangement of the original osseous structure.

False Exostosis—is an outgrowth of osseous tissue from the surface of a bone due to pathological changes in the bone tissue usually the result of excessive heat.

Habit Scoliosis — caused by faulty position of the spine during a long period of time. It rarely produces pathological changes in the vertebrae yet there is usually some deformity of the bodies which produces a lateral curvature of the spine.

Kyphosis—an abnormal, posterior curvature of three or more adjacent spinal segments.

Kyphotic Scoliosis—is a combination of posterior and lateral curvatures.

Laterality — refers to the side-slipping of atlas or axis and the relation of the spinous process with its own body. It might be said here that a spinal segment below axis will rotate to a greater degree than it will side-slip.

Lordosis — an abnormal, anterior curvature of three or more adjacent spinal segments.

Lordotic Rotatory Scoliosis—is a combination of an anterior curvature—a rotation, and a lateral bending.

Misalignment (Vertebral) — refers to a spinal segment being out of alignment with its articulation above and the one below. Such directions include Anteriority, Superiority or Inferority, Laterality, Posteriority and rotation.

Nasium and Vertex X-ray Work—pertains to certain procedures in placing the head and the tube for Spinographic analysis. These procedures differ a great deal from former methods of spinographic work.

Partial Dislocation — means that the superior zygapophyses or mammillary processes have slipped past one another on one side only.

Plane Lines—refer to pencil lines drawn on the film to determine the side-slip or point of wedge of Atlas; the position of the occiput on the side of point of wedge, and the superiority and inferiority of the Atlas.

Median Line—From point in center of foramen magnum to the point of gravitation. Draw line from inferior, internal point of one condyle to the same point at opposite side. Bisect this distance with right angle line. With everything equal this vertical line will extend in line with external occipital protuberance and nasal spine.

Posteriority — (Merically) this refers to a backward movement of a segment relative to the one above and the one below. Incidentally, an Atlas could not possibly move Posterior because of the odontoid of Axis, nor could an Axis move Anterior-Superior because of the anterior ring of the Atlas.

Rotation—(Merically) consists of three or more adjacent segments rotated in the same direction. In other words the bodies rotate one way placing the spinous processes in the opposite direction.

Rotation of Atlas—refers to the atlas rotating with one transverse and lateral mass moving to an Anterior direction, while the opposite side moves to a Posterior direction.

Rotatory Scoliosis—is a combination of a lateral bending of the spine and a rotation of the spinal bodies towards the lateral bending or convexity. The spinous processes will always be found to the concave side of the lateral bending.

Scoliosis — lateral curvature of three or more adjacent spinal segments, with spinous processes in the center of their own bodies or towards the convexed side of the curvature. In other words, when there is vertebral body rotation in a scoliosis it is always in the opposite direction from which the spine bends.

Static Scoliosis—is a lateral bending of the spine, adaptative to a short leg.

Subluxation—Atlas and axis specific a mis-alignment of Atlas and Axis, Atlas relative to occiput, Axis relative to Atlas and 3rd cervical. Therefore at least four directions are involved: Anteriority, Superiority or Inferiority, Laterality, and rotation of Atlas; Posterior-Inferiority, lateral tipping,

laterality of either the body or spinous process and rotation of Axis.

Superiority of Atlas — refers to the anterior ring of the Atlas pointing upward and the posterior arch pointing downward. There may be a lateral tipping of the Atlas whereby one transverse points downward and the opposite one upward, but they have no Superior or Inferior significance.

Superiority (Below Atlas)—refers to the lateral tipping of the vertebra. When one side tips high the opposite side tips low. Superiority if present is always listed on the side of laterality.

Total Scoliosis—a lateral bending with the spinous processes usually following the convexity.

True Ankylosis—a pathological condition wherein nature rebuilds or adds to the osseous structure to strengthen it.

True Exostosis — is caused by excessive heat wherein there is a proliferation of bone cells especially in the periosteum resulting in its ossification.

CHAPTER 2

THE VALUE OF THE SPINOGRAPH

Constructive progress always results in better and greater success. We find this element of progress and advancement present in every successful industry, in every successful business, as well as in every successful science. Their very life depends upon progress.

In the final analysis there can only be two steps — one forward, the other backward, nothing in between. In other words, to stand still also means to go backward, and this means failure. So to live, industry, business, and science must advance by taking that forward step.

X-ray is a science — Chiropractic Spinographic X-ray is a progressive science. It is quite young and no doubt many of its problems are still unfathomed; however, it is advancing for it is going on and on. Each year sees another problem solved, and therefore, naturally, better and quicker results. This implies that forward, advancing, constructive progress, which is gained only through continuous scientific research and experimentation. So the use of the Spinograph in the practice of Chiropractic is not a mere fad but an absolute necessity, if one wishes to advance and to render the best possible service in getting sick people well.

The importance and value of X-ray to the profession, from an analytical standpoint, has been constantly increasing from the time of its discovery by William Konrad Roentgen (Wurtzburg, Germany, December 28, 1895) up to the present time. Those who are engaged in this work realize its importance—its great importance—and they are certain that this will continue as time goes on.

It might be said that the Spinograph is a safety device to palpation, the one and only means by which mistakes and errors in palpation can be eliminated; therefore, its use is essential before an adjustment. However, to make that

adjustment and to insure its correction, precision must be your procedure. **The Stereoscopic Spinograph to know the exact position of the vertebrae, to be able to make correct contact and line of drive. The Neurocalometer to locate the interference or point of pressure, to know when to adjust and then to be able to put into the adjustment the proper torque delivered at the proper time.**

Perhaps there are some of the older practitioners who have remarked, "I do not need the X-ray. I have always obtained good results. I built my practice without it, so why should I undertake the expense and time necessary for installing such equipment?" Any practitioner who assumes such an attitude is certainly non-progressive. Palpation alone will, no doubt, hurt him individually, as it lessens his percentage of results and therefore his earning capacity; furthermore, it will lower the standard of his profession.

No matter how careful a palpator you think you are, no matter how efficient an adjuster you think you might be, without the Spinograph you will make mistakes and perhaps fail in many cases. It is surprising to check back through records and see how high the percentage of failures really was. Did you ever stop to reason that one failure to get results means the loss of, perhaps, hundreds of cases? This is quite evident when due consideration is made of the patient's immediate family, his relatives and his immediate friends. It takes professional, ethical, and constructive advertising, with a good common sense argument, to sometimes convince and sell people Chiropractic. On the other hand, it takes only a single failure to keep them from giving you an opportunity to prove its merits.

The eradication of only a few mistakes in your practice will more than pay for your X-ray equipment, for it will produce quicker, more accurate and more permanent results, thereby increasing your income. As stated above, it has been proved that many cases of errors in palpation are revealed by the Spinograph. Today in any Spinographic X-ray Laboratory there are to be found records of bent

spinous processes, exostoses, ankyloses, anomalies, malformations of all kinds, and other conditions which palpation could not reveal. It is very essential and important to list these abnormalities before proper procedure in adjusting can be attempted.

I do not exaggerate in the least, I believe, when I say that the majority of patients are afflicted with rotations, curvatures, scolioses, or rotatory scolioses which are impossible to detect by palpation. Thus, to adjust a vertebra in a rotation, without first knowing that a rotatory condition exists, implies that your adjustic move is going to be incorrect one way or the other.

Dr. B. J. Palmer once said: "There are just two main issues in Chiropractic business—results and health to the patient, and satisfaction in those results and profits to the doctor."

Medics also believe that these principles are true in their profession, and so admit they too cannot see with their fingers. Dentists adhere to the X-ray to locate defective and abscessed teeth so that extractions may be made only when necessary.

Without a doubt, the time has come when the Chiropractor must be judged in the same manner. When insisting on a spinograph of every case, you are looked upon as being thorough in your work and this is particularly true from the Atlas and Axis specific point of view.

To get results means more business, so why should Chiropractors not improve their service by spinographing every case, that they may see when and how the misalignment with side-slipping or rotation, is causing the subluxation. Also they can detect accurately the presence of pathological conditions, fractures, and dislocations. Seeing is believing, and X-rays if properly made never fail to reveal what there is to see.

Without a doubt, the X-ray is the keystone by which the progressive, up-to-date Chiropractor can be recognized. Therefore, it behooves each and every Chiropractor to have

and operate an X-ray machine in his office. It will give him more confidence in himself, and too, it is much more convenient for one to have access to such equipment at all times, instead of having to refer one's patients to some other Spinographer or Practitioner who has X-ray equipment. Having this equipment in your office always has a decided psychological effect upon your patient, and especially is this true when consulting prospective cases.

Because of the inability to correctly palpate a High or Low condyle, the Anterior Superior, Anterior Inferior, and Anterior ring of the Atlas or its rotation and the position of the odontoid process of the Axis, as well as the body of axis, it becomes necessary to spinograph a lateral and anterior to posterior cervical spine to definitely decide the true specific position of Atlas and Axis with one another and their relation to the condyles and 3rd cervical. This is also true merically to determine bent spinous processes, exostotic growths, ankylosed conditions, long and malformed transverse processes, and cleft spinous processes. All these make palpation very difficult, if not impossible.

There are a certain few individuals who cannot open their mouths widely, some naturally have low occiputs, and others have permanent bridge work or large gold crown teeth. These conditions make it difficult to always get good, clear, unobstructed A to P spinographs of the upper cervical region. In this event, perhaps a third exposure from A to P through the nasium or nasal cavity may be of some benefit. These films also seem to have some merit as a matter of verification when deciding the wedge or side-slip of the ordinary A to P cervical exposures. Formerly there seemed to be some doubt whether or not the slightest wedge or side-slip was actually true of the position of the Atlas and condyles or whether it was the result of a malformed occiput, or whether it was due to distortion caused by the angling rays, by misplacement, or by an unnatural position of the patient during spinographic placement.

Years ago we talked of the advisability of spinographing

in the upright position, but not until the Atlas-Axis specific idea became a working practice did we actually realize the importance of the upright, normal, relaxed posture. Experimentations were carried on and conclusions were that the patient sitting up could and did assume a more normal, natural, relaxed position for spinographic exposures. Although the difference in the positions as revealed on the natural or flat spinograph films, using either prone, supine, standing or sitting postures, seldom revealed the opposite misalignment or subluxation, quite often it changed the general appearance of the spine on the film. This tends to increase or decrease the curvatures or change the position of the occiput as seen on the X-ray film.

During the summer of 1934 we again took up the idea of stereoscopic cervical work and our conclusions, after many months of scientific research and experimental work were that we could and did produce sufficient depth on our upper cervical pictures to bring out the third dimension. In other words, using this method to make such pictures one can clearly determine the rotation of the Atlas. This is of vital importance to the Chiropractor—for a large percentage of the Atlas subluxations reveal Atlas rotation as the major direction. It really is the fourth direction to be considered.

How often have you heard the following comments? "Dr. So and So had cervical spinographs made but the patient got no results." Perhaps such remarks were made of your case. Maybe you failed to get results. However, many times similar statements are made and often these are quite true. For instance, a case was spinographed and the patient who did not get well, either became discouraged and discontinued with the adjustments, or continued, with few results for several reasons. Spinograph listings may have been partially incorrect or even discarded and the adjuster moved over on the opposite side of the patient, or he may not have had the mechanical perception necessary to know where to make contact, etc. Then sometimes if results were not forthcoming, he reverted to contacting up and down

the back or perhaps he may have added adjuncts to his office equipment.

Obviously then, such failures may be the result of not knowing what to adjust when only flat or natural pictures are used; when information is very limited, or when incorrect procedure pertaining to placement has been practiced. Also, inability to correctly interpret and analyze the films, improper contacts or the incorrect line of drive and adjustic thrust may have produced the failures. Thus it would seem that Stereoscopic pictures might obliterate much doubt.

Working equipment and technic procedures are being constantly experimented with and improved upon for the purpose of providing more information through the medium of X-ray films. And with this better quality of radiograph or spinograph there is more information available and so this work becomes more important.

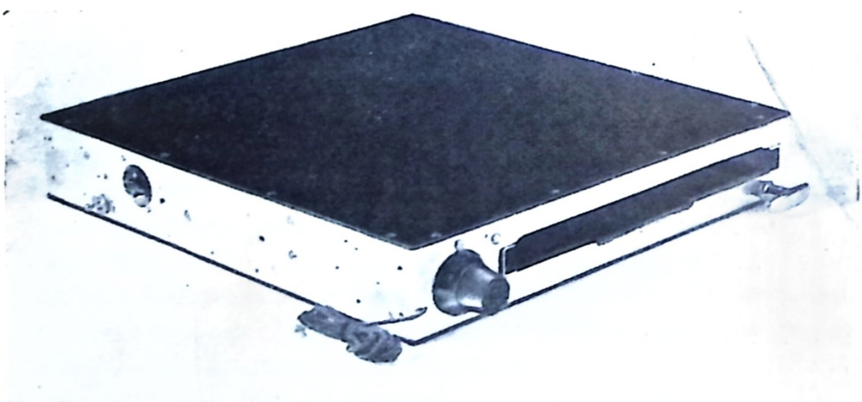


Figure No. 5
8 x 10 Bucky Diaphragm

CHAPTER 3

ESSENTIALS IN DEVELOPING THE X-RAY LABORATORY

Essentials in developing the X-ray laboratory are the equipment, technical procedures, and their interpretations, all of which are of equal importance.

Equipment

The technician or spinographer must be provided with the proper equipment. The selection of such has much to do with the success or failure of his efforts. His progress and success may be made very difficult, even impossible, or it may be made very easy — according to the equipment he chooses. This equipment must be arranged in a practical manner in order to do precision work, and must have sufficient capacity to do the work undertaken. The machine must be capable of delivering the energy required; the tube must be of the proper type and of sufficient capacity to carry the necessary energy and to deliver the energy thereby developed.

Experience has revealed that better results are attained in spinographic work by first employing the use of at least a 90 Kilo-Volt-Peak — 30 Milliampere Unit. Even greater capacity would be more satisfactory because it is often necessary to do the work instantaneously. This is true when spinographing children, certain physical and organic conditions as well as in stereoscopic procedures. To do the work upright, preferably sitting up, necessitates the use of the Vertical Cassette Holder which may be used in most any conceivable angle and to which a small Bucky Diaphragm may be attached. A turn table should be added to the Cassette Holder in order that proper placement of the patient may be manually made without exerting the patient whatever, and still keep the case in a normal relaxed pos-

ture. Incidentally, such equipment performs most efficiently, and very conveniently as well, in the placing of extremities for fracture, skull, or even dental work. The track is included in the precision method in as much as perfect alignment of machine, tube, and film or Bucky Diaphragm may be had.

Any attempt to successfully and consecutively stereo cervical regions or spinograph a pelvis, radiograph the chest, heart, or any other organ, of a 250 pound individual, using a small dental unit could only result in a complete failure. Likewise to attempt to spinograph or radiograph heavy individuals with a fine focus tube, would in all proba-

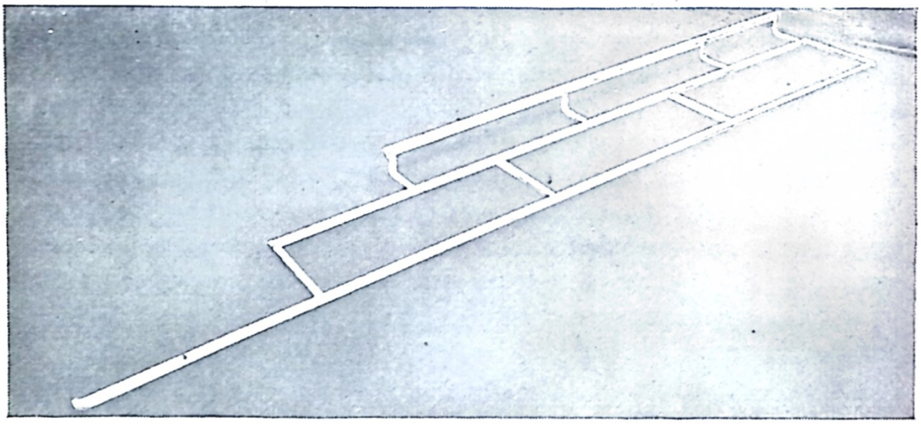


Figure No. 6
Vertical Cassette Holder Track and Guide for Movable X-ray Unit or Tube Stand
Other single, duplex and triplex tracks are available.

bility result in breaking the tube, as this type of tube lacks the capacity for doing such work.

It is very important that the unit be provided with the proper controls, for the controlling of factors; tube distance, time, milliamperes, voltage, and kilovolt peak or penetration. There is no difficulty in controlling the tube distance, for when once determined it ordinarily remains the same. The time factor is of more importance, especially when frac-

tional seconds are used. With exposure from three to five seconds there may or may not be a small percentage of error with the use of the ordinary clock or watch. But whenever fractional seconds are used, an automatic timer should be applied in order to make duplicate exposures. In stereoscopic work this factor must be under definite control.

The milliampere factor necessitates the use of a graduated milliampere meter. With perfect outside line conditions, the milliampere factor should remain constant—once it is determined and fixed. However, should the milliamperage fluctuate, a stabilizer is the best known method of controlling this condition. Voltage, kilo-volt-peak or penetration is compensated and controlled by an evenly graduated auto-transformer.

Technic

Careful, desirable technic requires considerable skill, and skill is something one cannot buy. It can be obtained only by continued practice and experience, and even then every one that studies X-ray would not make a successful operator or technician. No set rule can be applied accurately and successfully to determine the proper technic for any two individuals, particularly in different localities. Hence, height, weight, thickness of tissue, age, physical and even atmospheric conditions, variations in current, peculiarities of machines and tubes, type and condition of films and intensifying screens, solutions and your own idiosyncrasies are all of importance when deciding your technic.

There are many other factors that are likewise important; such as time, tube distance, milliamperage, voltage, placement, size of focal line or spot, lag, grain, contact and cleanliness of screens, speed and quality of films and the proper darkroom technic and procedure. All in all, there are many factors that make for a clean, clear cut, readable film.

The production of suitable films, really presents a difficult problem. As has been pointed out the very first requirement is complete modern, up-to-date equipment, used with skill and accuracy. Next to consider is the object of the

X-ray picture and the region of the patient to be exposed. This information is ordinarily sent to the X-ray laboratory but occasionally such determination is reached by the technician himself, through the history of the case and physical examination.

Then the position of the object in order to get the best possible results must be determined. Sometimes it becomes necessary to make a second or third exposure, changing positions each time until the proper one is found.

Finally comes the correct machine technicalities to be used, referring now to the exposure time, tube distance, milliamperes, and penetration. As various degrees of density are obtainable, the roentgenologist or technician decides that the density which is most satisfactory to himself is perhaps to the doctor who refers the case.

Inversely as the square of the distance, all other factors remain equal. For instance, if the distance is doubled only 1/4 of the radiographic density would result. Continuing, if the exposure time is doubled, so would the radiographic density.

Directly with the milliamperage, all other factors remaining equal, the milliamperes doubled would double the density.

Increasing the voltage or kilo-volt-peak, the density is increased and vice versa.

The first exposure is usually more or less guesswork. Exclusive laboratories refer to this as a trial picture. Here is where experience plays a part. The more experienced the technician is the closer his work reaches the desired point. Yet pathology may be unknown, for radiopacity of individuals having apparently the same dimensions, cannot be exactly determined the first time.

Exposure time really depends upon the length of time the object can remain still. Sometimes a fractional second exposure is necessary to eliminate any motion appearing on the film. Then again, more time may be used to advantage. X-ray exposures are somewhat synonymous to photo-

graphic procedures in so far as a time exposure always makes the sharpest print, providing of course, all motion is eliminated.

Distance refers to the separation of film and X-ray tube. If using the Bucky Diaphragm, the correct distance should come from the Bucky manufacturer for he knows the construction of his Bucky Grid which determines the tube distance to be used. When operating without a Bucky perhaps a 32" distance, if the object is in close proximity to the film, this distance will produce the approximate actual size of the object. Where the object is not in direct contact with the film, then an increase in the tube distance is necessary. Such distance may be increased to 72". Industrial X-ray work has proved tube distance to be as much as 60 feet.

The milliamperage ordinarily used in spinographic work ranges from 20 to 50, (sometimes it is less and occasionally more) and in other radiographic procedures from 10 to 100; however, a lesser amount of milliamperage is needed only when the exposure time is extended and vice versa. This always produces better results.

Penetration and time are variable factors, while other steps in the procedure remain more or less fixed. The correct amount of kilo-volt-peak is gained through keeping a daily record chart. Then a careful study of the pre-reading volt meter makes it possible to duplicate exposures.

Standardizing the darkroom procedures should require a full five or six minutes development except when the film is over-exposed. Then the development becomes a variable factor. The arrangement of the different steps in machine operation to the point where films will develop a full five or six minutes will produce the best radiographic results. Incidentally, developing time varies because of the different makes of film.

Before concluding this subject there is another factor which plays an important part in any field of endeavor and that is one's location.

It is the writer's opinion that in many instances more favorable places could be found. For instance, an out of the way place is not advisable, that is, one not near a transfer corner, one away from the mass of people, or where parking space is not available.

Also to operate in a building without an elevator, if above the first floor, is not a good policy. In such a location it would be almost impossible to receive trauma cases, as well as many other types of patients.

IT IS WELL TO REMEMBER THAT X-RAY TECHNIC VARIES BECAUSE OF THE PROGRESS OF ITS DEVELOPMENT, DUE TO CONSTANT RESEARCH AND EXPERIMENTATION, AND BECAUSE OF THE INDIVIDUAL HIMSELF AND PERHAPS HIS LOCATION.

Interpretation

The most expensive equipment with ideal line conditions and perfect installation, combined with the efforts of the best technician available may not obtain results, unless one is qualified to interpretet or read the films. This is true from either the Medical or Chiropractic viewpoint, so the practitioner of either profession must be capable and sufficiently trained to make correct interpretations.

Film interpretation not only requires a thorough knowledge of the normal and abnormal structures, but also a knowledge of its application from an X-ray standpoint.

Technically, the equipment should always function properly, placements should always be correct, then the clearer and sharper the film, the more information will be available.

An X-ray Laboratory represents a considerable investment and it is the writer's opinion that when the essentials mentioned above are carried out, the laboratory will always prove successful from a financial standpoint. Also there is satisfaction when one renders efficient health service.

CHAPTER 4

SUMMARY OF X-RAY MACHINE OPERATION

Though the principle and theory of X-ray are the same the world over, all machines do not operate the same. In other words, the various knobs and levers on the working panels of the different units are not in identical positions. Naturally, to become thoroughly familiar with one machine and its operation does not mean that one could step into a strange laboratory and begin immediate operation on another type of unit. However, with a little study or explanation one could eventually operate it.

I am not referring now to technic, such as the Kilo-Volt-Peak, Milliamperage, tube distance, and time — you know that approximately. I am referring exclusively to machine operation and manipulation.

May I repeat that all who study X-ray technic and operation, whether it be Chiropractic, medical, industrial or otherwise may not be successful. This is true in any field of endeavor.

All X-ray manufacturers when installing X-ray units and equipment make certain tests in the practitioner's office and it is customary to instruct him how to operate the machine, help him take a few pictures and supply him with a technic chart. Then with the foundation obtained in his X-ray course he should be able to work out his own technic. REMEMBER, ALL WHO TAKE UP THIS WORK DO NOT MAKE SUCCESSFUL SPINOGRAPHIC TECHNICIANS.

The operation of the motor rectifying type unit differs somewhat from the smaller motorless self rectification or valve type. The latter refers to the type in which the tube rectifies the current. Using the rectifier or motor type, it is not advisable to test out the machine while the patient is on the table or in an upright posture in line with the tube, as the snapping of the current on and off across the term-

inals often frightens the patient. Especially is this true of children and of adults who have never been X-rayed.

Make sure the X-ray tube or chair is properly grounded to eliminate all static electricity, otherwise the patient will feel a tingling or prickling sensation which may cause them to move at the beginning of or during the exposure. This would cause the film to be of no value and a retake would be necessary.

If possible always make the test for Kilo-Volt-Peak and milliamperage or machine technic, if same is necessary before the case is placed.

The usual steps in the operation of the mechanical rectifying units:

See that all switches are disengaged or that the knobs with indicators point to zero except, perhaps, the **rheostat controls**, often referred to as the **Capacity Selectors**, which should always point to a certain setting for radiographic work. The other half of the control should be on fine or medium location. This control becomes a constant when once determined. Incidentally, in the newer, modern types of equipment, the separate and distinct rheostat control is eliminated.

Turn on the wall switch, allowing the current to travel through the switch to the machine.

Engage the motor switch which starts the motor. This in turn revolves the rectifier and automatically determines the direction of the current flow through the tube, so indicated by the indicator within the polarity meter, also to start the motor usually lights the filament end of the tube. If the indicator does not point to the proper direction, open the motor switch and repeat the operation. Eventually this procedure will direct the current in the proper direction. In some of the older types of equipment, there is a separate and distinct control for the lighting of the filament.

Having decided on the amount of Kilo-Volt-Peak and Milliamperage, the auto-control knob or knobs are set. Some units have a single control while others employ the

use of two, the latter being of finer graduation. Usually the steps on one dial of this control are numbered while the other steps are lettered.

When using a milliampere meter with two distinct scales, the divisions may be changed by pulling a string attached to the meter, thus raising or lowering the scale so as to read the desired number of millamperes. The lower scale usually reads 0—20 and the upper 0—200.

After determining the calibration of the machine then set the filament control knob or lever for the desired amount of milliamperes. WHEN THE MILLIAMPERAGE INCREASES, THE KILO-VOLT-PEAK OR PENETRATION TENDS TO DECREASE AND WHEN THE MILLIAMPERAGE DECREASES THE PENETRATION TENDS TO INCREASE. Therefore it behooves the operator to attempt to control the Milliamperage during the actual exposure. Regardless of what type of machine used, testing and setting of controls should be done before placing the patient.

If using the Bucky Diaphragm, check its timing device with the film or cassette properly placed. All Bucky grids must travel a short time before the actual production of X-rays begins and then continue briefly at the end of the exposure to eliminate grid lines on the film.

When controlling the exposure time with the automatic timer set it for operation.

If Stereoscopic pictures are to be taken, check the proper tube shifts.

Instruct the patient to sit or lie perfectly still, as there will be nothing to harm him.

While observing the patient through the leaded glass either from behind a protection screen or preferably from within a leaded booth, the technician should be able to operate the timer, and trip the grid. If the machine does not have a bucky release he may then have to operate without lead protection, which is not a desirable procedure.

It is always advisable to develop the films immediately after the exposure instructing the patient to keep the same

position as nearly as possible until the films are developed. This procedure should only take approximately 8 to 10 minutes.

When using the more modern equipment, which is noiseless, such as self and valve rectification, engage the main switch, or main switch on machine. This may or may not light the panel but will the tube, and the current will always flow in the proper direction. Determine and set the filament control, also the voltage or auto-control. Some machines have a pre-setting meter which when set at a certain point with filament control already set assures one of a certain Kilo-volt-peak. In other words, using a pre-setting figure one can always duplicate the same combination of current and voltage. However, in either case be sure the tube is free from dust and allow a few minutes after lighting the tube, so to speak, before actually producing X-rays. For in case the tube is cold or dusty a quick or heavy charge of current might break the tube.

The following is a brief outline for operating the more modern type of X-ray equipment.

Turn on the wall switch. Either 110 or 220 volts, alternating current may be used. Certain changes in connections inside of the machine can usually be reversed to operate on either voltage. If the direct current is to be used, a rotary converter is necessary.

Make the proper setting of the auto and filament controls so indicated by proper meters and then check the entire desired amount of penetration by reading the pre-setting meter.

Set the timing device for the grid travel, and in X-ray terminology, cock the Bucky Grid, with the film or cassette in proper place.

If Stereoscopic pictures are to be taken—make the proper tube shifts.

If using the automatic timer—set it for the proper exposure time. Otherwise push the Bucky release button located on the working panel of the machine. This automati-

cally starts the grid to travelling. Then the production of X-rays begins.

When operating a double focus tube (of different focal width) select the desired focal line by throwing switch in proper direction.

The patient should remain in the same position as nearly as possible until the films are developed.

CHAPTER 5

THE X-RAY TRANSFORMER AND CONTROLS

It is generally conceded that a poorly equipped X-ray laboratory is not only limited to a certain class of work, but that such work oftentimes cannot be relied upon.

The author well remembers when technical procedures were so vague, so inaccurate that proper alignment or the precision methods were unthought of. Only the image, regardless of any contrast or detail was obvious. How could such work be dependable? But even today in our rank and file similar procedures are carried on. Perhaps this is because many of us are prone to stay home and do not assemble to learn of the different ideas which would keep us abreast of the times. The modern X-ray laboratory requires the use of complete, carefully designed precision equipment in order that the very maximum quality results will be obtained. Then either the direct or alternating current must be available. Direct current machines are in the minority perhaps the world over, as they usually have a lesser output than the alternating machine. This is due to being limited by the capacity of the rotary converter, which of course is required to change the direct current to alternating. This is necessary in the production of X-rays.

Using Direct Current

As direct current cannot be increased to a high enough voltage for X-ray requirements, the alternating current and the rotary converter are necessary. A rotary converter, large enough to make the direct current machine as efficient in capacity as an alternating current machine is considered impractical because of its immense size and expense. The function of the rotary converter is to increase its speed momentarily, then to decrease the current with a corresponding voltage drop to the step-up transformer. If the ex-

posure time is under a heavy load long enough to cause the speed of the converter to slow down, it will result in a drop in voltage.

The voltage to operate a direct current machine is usually 110 or 220 volts; 220 volts being more desirable. To avoid limiting its output, the size of the main line wires supplying the machine must be relative to the capacity of the unit and the distance from the pole transformer to the main line switch. For the ordinary radiographic machine the line is usually fused to carry sixty amperes. A number six or eight wire is usually of sufficient size for the larger radiographical machines for the greater the distance from the pole transformer to the main line switch, the larger the main line wire must be to decrease the line voltage drop.

Using Alternating Current

Today an alternating current machine is most frequently used for the production of X-rays. It is usually supplied from your immediate power plant or transmitted from a nearby substation to a pole transformer which should be located as near to the X-ray machine as possible. Its voltage is comparatively high, amounting to 23,000 volts or more.

The action of the pole transformer is to step down the electrical supply to the value which can be safely used for the occupant's needs. For X-ray use it usually transmits 220 volts; however, occasionally only 110 volts are supplied, the amount of voltage used for general heating and lighting purposes. The pole transformer consists of a steel core with primary and secondary wire winding placed within a weatherproof box. The core is immersed in transformer oil. The transformer should be of sufficient capacity to permit the X-ray machine to create its maximum energy. An additional load necessary to operate elevators, ice machines, etc., should not be placed upon a transformer supplying X-ray machines for there is the possibility of overloading and this would limit the X-ray output.

A fuse box with proper fuses should be placed within the main line, near the main line switch, for safety purposes.

A main line switch of the concealed type should be installed conveniently near the X-ray unit so that the current may be cut off when not needed. Should one attempt to do any mechanical work on his X-ray machine he should first disengage the main switch.

Auto-Transformer

The auto-transformer is a control device which reduces the line voltage and operates very efficiently. It is connected across the main line circuit so as to vary the voltage from the main line to the step-up transformer. It acts as a valve which supplies the amount of current demanded. It may be constructed with a single or double lever and button control. No doubt the control offers a finer graduation, that is to say a more definite KVP may be had. Its design is indeed important as such a transformer has an inherent drop in proportion to the current passing through it. Naturally the better the design, the less voltage leakage there may be. There are a number of equally spaced uniformed voltage steps or connections to regulate the voltage, and each step produces the same electrical variation on the primary side of the main transformer. Usually this ranges from 50 volts up to the entire voltage of the incoming main line. Some of the older types of auto-transformers are graduated in only three steps, namely: lower, medium, and high. Any further variation would be mainly in the exposure time itself.

The auto-transformer will not stabilize the current. The voltage drop through the auto-transformer is based upon approximately 10 per cent of the line drop. If the auto-transformer button and indicator points to a number or step delivering 150 volts, the approximate drop would be 15 volts.

Rheostat

The rheostat is resistance used to consume a part of the line voltage. It consists of either the coil or grid type, and is placed in series (on one side of the line) between the auto-transformer and the step-up transformer. In the more modern equipment such a separate control is being eliminated. When used, however, its purpose is to limit the power delivered to the primary side of the step-up transformer for obtaining intermediate values of the primary voltage in connection with the auto-transformer. The grid type is said to dissipate heat more rapidly than the coil type. This permits a longer operation with less voltage drop. The rheostat is used very little as a control for radiographic purposes because the slightest variance in the milliamperage causes considerable change in the secondary voltage. When the rheostat step is once determined it should remain there for all radiographic and Chiropractic spinal purposes. When the auto-transformer is used the milliamperage may vary over a wider range with only the slightest change in secondary voltage.

Pre-Reading Volt Meter

In working towards a high standard the scientific chiropractor created a demand for stereoscopic spinographic views and natural or flat graphs, taken before adjustment with subluxation, and after adjustment without subluxation and then with intermediate check sets taken between. All this not only necessitated the absolute use of a posture constant, the essential of all spinographic sets of the same individual, but it also required a constant duplication of Kilo-Volt-Peak, as well as the actual exposure time.

It then became necessary to employ the use of a meter constructed within the X-ray unit and connected in the auto-transformer circuit — for measuring the voltage delivered by each auto-transformer step to the main transformer. This meter pre-reads the voltage value of each auto-transformer step as soon as the main switch of the

machine is engaged. If one is using the motor type of unit, it pre-reads the voltage as soon as the motor switch is turned on, before the X-ray switch is closed. In this manner the Kilo-Volt-Peak value may be pre-determined and duplicated. No doubt there are other methods used but seemingly none as satisfactory as the one described above.

Milliampere Meter

This meter gives an accurate reading of the current in milliamperage going through the tube. A milliamperage is 1/1000 part of an ampere. In X-ray work it is used as a more convenient way of reading this type of current. Incidentally, different amounts of milliamperes are used in various technics for perhaps the same region.

Polarity Indicator

In operating the X-ray machine it is understood that the electric current must pass through the tube from only one direction, cathode to anode. This is determined by a polarity meter when using the alternating current with mechanical rectifier. A device, known in electrical terms as a polarity commutator, is attached to one end of the motor shaft which supplies the current that operates the indicator or needle in the polarity meter, and thus it indicates the direction of the current to the tube. This commutator is so constructed that it changes the line voltage from an alternating current to a uni-directional one — by stopping each alternating wave or half cycle. In this way it prevents the high tension current from traveling across the tube in the wrong direction.

Either a primary reversing switch or the motor switch is used to operate this polarity indicator. The latter is most commonly used.

When starting the motor, if the indicator is found pointing in the wrong direction, disengage the motor switch and immediately, re-engage it. This procedure will force the indicator to point properly.

When using the self or valve rectification units a polarity switch is not necessary.

The Main Transformer

The main transformer, otherwise known as the step-up transformer, increases the low voltage current to the required higher voltage. It usually ranges in operation from as low as 50 volts up to and including 220 and sometimes even uses as much as 60 amperes. The maximum voltage of the smaller units is approximately 90,000, while that of the larger types will run as high, and sometimes higher than 150,000 volts. Ordinarily 90,000 volts or 90 Kilo-Volt-Peak is sufficient penetration for any bone work. As a matter of fact, it is ample for almost any type of radiographic work.

The entire system of the step-up transformer is insulated and immersed in oil. The top of the transformer should be kept clean, free from dust, dirt, and oil. Any oil leakage must be stopped immediately.

The oil level should be examined periodically to keep the oil well over the top of the coils. This prevents possible shortage and completes the expulsion of air. Inspection of all connections to see that they are tight further aids getting the best results.

Synchronous Motor

This motor is one in which the speed is timed exactly with the frequency of the alternating current. It is the only type of AC current motor to be successfully used in operating the mechanical rectifiers in order that rectifying elements be always in proper position with each alternation of the alternating current wave.

When only direct current is supplied the rectifier is revolved by a rotary converter. This keeps the speed correct and also changes the direct current to alternating, in order that it will be increased to the desired amount by the main transformer.

If the motor does not synchronize with the AC frequency

it will in all probability ruin the tube; sometimes, however, the rectifier would prevent this. Such a condition may be determined by the polarity needle swinging from side to side.

Mechanical Rectifier

There are two forms of mechanical rectifiers, the cross arm and the disc type. Though the quality of radiation delivered is practically the same using either type, perhaps the former is the most popular. They both are operated by the synchronous motor. Their purpose is to change the high tension AC current, leaving the step-up transformer, to a pulsating direct current before it reaches the X-ray tube.

It is very important that the rectifiers are correctly placed on the motor shaft, relative to the motor armature. If out of phase, the arcing between the rectifier contact becomes long and results in the loss of tube current or penetration. Only machines carrying a capacity of over 90 KVP at 30 MA necessitate the rectifiers.

Although X-ray machines with mechanical rectifiers are being steadily replaced with valve rectification, the writer feels it is necessary to briefly explain this type because there seems to be many more such units in operation today.

High Tension Circuit

The high tension circuit provides for the passing of the pulsating direct current from the rectifier through the milliampere meter and indicates the amount of current going through the tube.

The overhead aerial and reels or shockproof cables carry the high tension current from the machine and deliver it to the tube. There are two terminals at the cathode end of the tube, and one at the anode end.

Filament Circuit

This circuit provides current with proper controls for heating and lighting the filament. The necessary voltage

ranges from 5 to 12 volts. This current may be supplied from a separate transformer commonly known as a filament transformer which in reality is a step-down transformer. In the modern day equipment this voltage arises from a low voltage winding of the auto-transformer.

Operator's Control Panel

The operator's working panel includes such controls as the main switch; the X-ray switch; Bucky Release button, and motor switch (if using the mechanical rectifying type); auto-transformer knob or knobs (referring to single or double control); rheostat knob or lever (if a rheostat is used); milliampere meter; Kilo-Volt-Peak meter; pre-reading volt meter (meters have knob or lever controls); polarity meter and indicator (when not using the self or valve rectification unit), and pilot lights. Usually there are two plug receptacles for plugging in the automatic timer or foot switch.

Stabilizer

A stabilizer is sometimes added to the X-ray laboratory equipment. It ranges in operation from approximately 5 to 100 milliamperes and is made in two types so that it operates with either the mechanical rectifying unit or the rectifying tube type unit, itself. It is connected in the secondary circuit of the high tension and filament transformer.

Its function is to maintain a steady flow of current through the X-ray tube — no matter what variations one may find in the line voltage. The stabilizer, once set for a given milliamperage, remains fixed, permitting only that certain amount of current to pass through the tube, unless otherwise reset for a different amount of current. The accuracy of such a device is said to be such that, upon one setting, it will deliver the same amount of current through any two radiator types of tube. Also it adds life to the X-ray tube where tube testing is necessary. It works similarly to a thermostat, no more, no less, when once set. However, it may be set for various milliamperage.

Most all of the larger exclusive X-ray laboratories are equipped with such a device because, throughout the larger cities, a fluctuation in X-ray current is indeed a menace. Incidentally, the stabilizer will not increase the milliamperage over and above the machine or tube capacity.

Automatic Hand Timer

The automatic timer can be used to great advantage in duplicating exposures, so far as time is concerned, although the use of such a timer may not be absolutely essential.

X-ray technic will possibly vary as much as 10 per cent or more in different localities due to line variation or fluctuation; quality of screens, and the use of various types of tubes, etc. But a given technic, good screens and the proper darkroom procedure, without any line variation, will usually produce very good results in duplicating exposures.

CHAPTER 6

CALIBRATE TO STANDARDIZE TECHNIC

It has been our policy, here at the P. S. C. to standardize our machine technic. The primary object is to simplify, as much as possible, the Spinographic work for those who desire to take X-rays of their patients. Where all machine technicalities are variable factors, that is, milliamperage, kilo-volt-peak, time, tube distance, etc., it is quite difficult for the average person to calculate correctly. This results in a poor film and so it is with the majority of field practitioners who take spinographs of their own cases, as well as attend to the rest of the practice procedures.

It is possible for a technician who has specialized in X-ray and who applies all of his time to this work to make any or all of the technical factors variable, but it takes constant practice and much thought. It has proved the best policy here to standardize technical factors of each type or film, for all patients. The varying factors usually are the kilo-volt-peak and time. Of course there are exceptions; such as in the case of infants, in conditions of paralysis agitans, or in those cases where immobility for any length of time is impossible.

It is very difficult to give a technic that will be applicable for all machines, tubes and patients. Several factors enter into this: a slight difference in transformer, windings, different size focal lines and tubes, different makes of tubes and too, there is the altitude and barometric pressure to consider, as it seems to affect the quality of X-rays, condition of patient, etc.

Calibrating the machine and each tube eliminates any testing of equipment before use and then also, one knows just what a given setting will produce—so far as Kilo-Volt-Peak and milliamperage are concerned. However, this practice cannot be depended upon if you are having a great deal of variation in current.

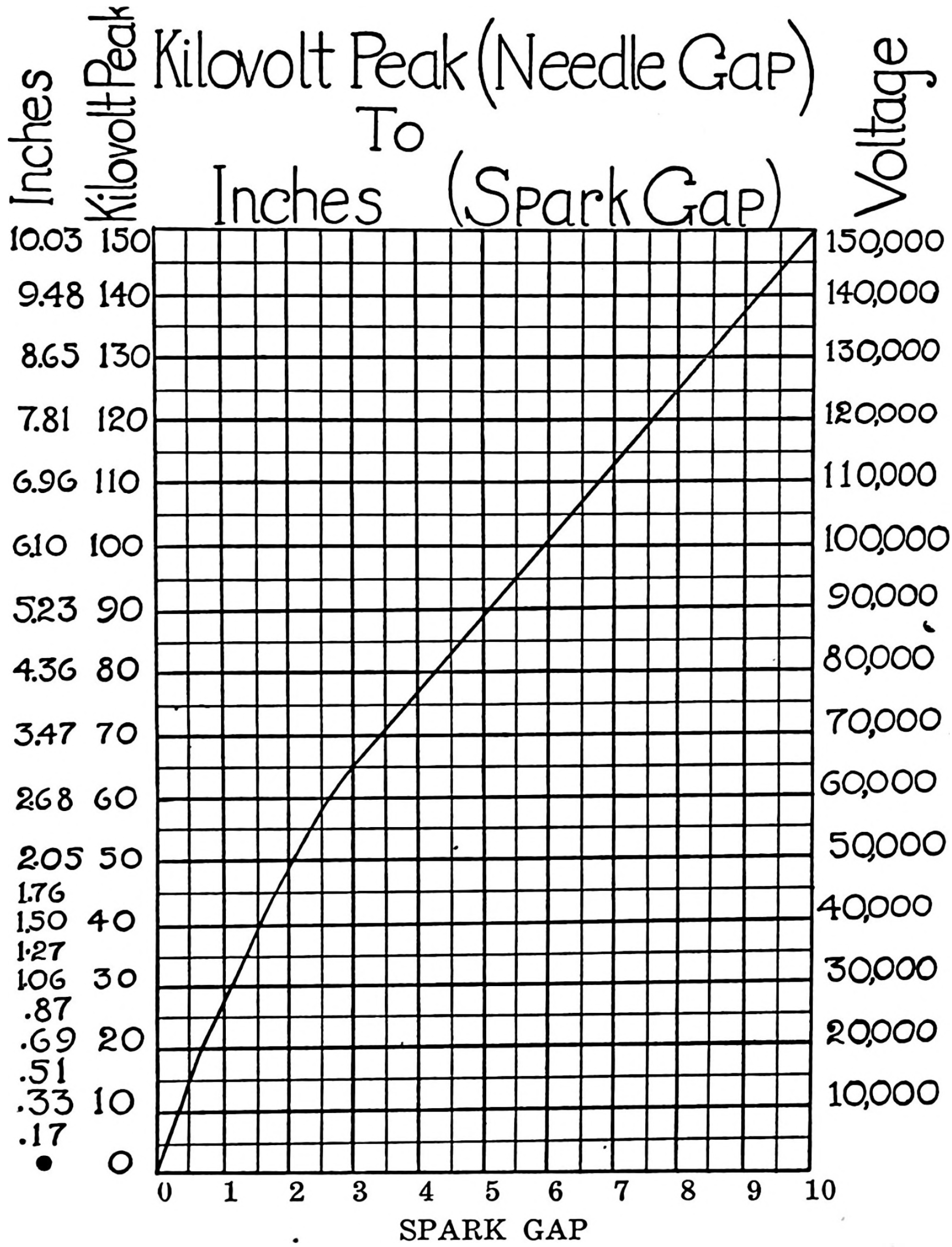


Figure No. 7

To Convert Inches (spark gap) to Kilovolt Peak, read upward along the vertical lines to intersect the graph lines

This method is really a time and money saver and naturally obtains better results.

Sphere Gap

The sphere gap is a device for measuring the high tension alternating voltage across the terminals of the X-ray tube. It is said to be recognized as the only accurate instrument for the practical measurement of such voltage.

To check with the use of a sphere gap enables the results of a certain Kilo-Volt-Peak on one machine to be duplicated on another. To calibrate each machine and tube by employing the sphere gap will materially aid in a better quality of radiographic work. It is essential to know that X-rays may be duplicated in retakes or comparative sets.

Such a device as the sphere gap is connected in the circuit as near the tube as possible. When ready to test it engage the X-ray switch with the spheres—far enough apart to increase the current resistance to that point which will allow the circuit to pass through the tube. Then operate the spheres by pulling a cord. This moves them slowly toward one another until the resistance becomes greater in the tube than at the point of the two spheres or until the current arcs from one ball to the other. At that instant read the Kilo-Volt-Peak calibration sphere gap. One should make two or three attempts in making the test to be accurate.

To chart each step of the auto-control in this manner, will lead you to a certain setting of both auto and filament controls, for a given amount of kilo-volt-peak at a certain milliamperage.

CHAPTER 7

BUCKY DIAPHRAGM

There is a peculiarity of the penetrating power of the X-rays in that when they strike and pass through the body they cause a secondary radiation which fogs films. Ever since the presence of such rays has been known, one definite aim has been to eliminate them as much as possible.

So to Doctors Potter of Chicago and Bucky of Germany belong the credit of materially increasing the analytical and diagnostic quality and value of the X-ray work — by eliminating a greater amount of secondary fog through the development of the Bucky Diaphragm.

The Bucky Diaphragm is made in various sizes and its purpose is to eliminate the secondary radiation which causes fog to appear on the developed film. This fog is perhaps the greatest menace one has to contend with when making an X-ray exposure. When the bucky diaphragm is properly constructed, it should prevent from 70 to 80 per cent of the secondary rays reaching the film. By eliminating these rays the percentage of contrast and detail is amazingly increased. There may be some disadvantages in using the Bucky Diaphragm, such as a slight loss of detail because the object is not directly in contact with the film, so to speak, and possibly there may be some grid marks and longer exposures. But the advantages of eliminating such a high percentage of secondary radiation seems to far outweigh the disadvantages. The Bucky Diaphragm is especially used for spines, skulls, gall bladders, and some gastro-intestinal tracts, etc. It is rarely used in making chest, either heart or lung, or in regional radiographs, such as wrists, hands, elbows, arms, knees, feet, ankles, etc.

The principal working part of the Bucky Diaphragm is the movable grid; its efficiency is determined by the height of the lead strips, their thickness and the thickness of the wood strips between each lead strip. Each bucky is tested at a given tube distance. This grid is controlled by tension

springs and an oil cylinder which allow it to travel from side to side in synchronism with the exposure time. That is to say, the grid must be in motion at the beginning of the exposure and in motion at the end of the exposure. In other words, say the actual exposure time was ten seconds—the

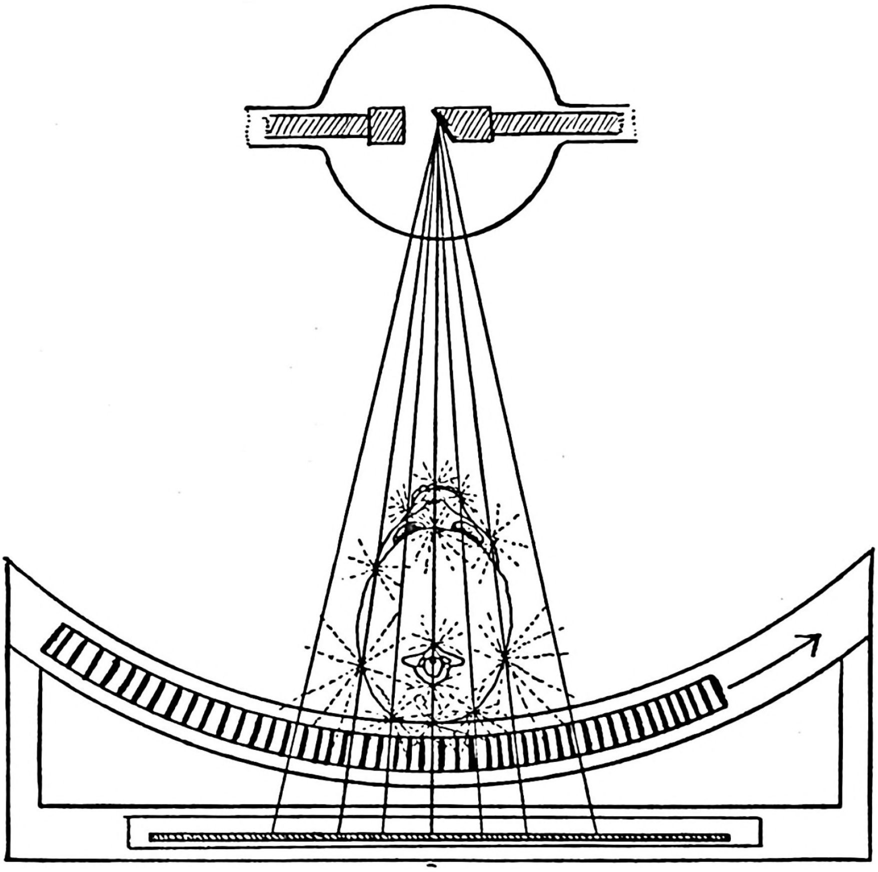


Figure No. 8
Curved type Bucky Diaphragm showing direction of X-rays and secondary radiation

approximate running time of the grid traveling from side to side would be approximately fourteen seconds. If this grid should stop its motion during the exposure there would be white lines developed on the film indicating the lead strips of this grid. These naturally interfere more or less

when analyzing or listing the film. Then too, if the grid should stop there would not be a great deal of reduction in secondary radiation.

There are two types of Bucky Diaphragm on the market today—the curved one which has a curved grid, constructed with a radius of approximately twenty-five inches, the other a flat Bucky with a flat grid. (See Figs. 5A and 8) The flat Bucky is perhaps more generally accepted as the most satisfactory type, although there are many curved Bucky Diaphragms used today. The flat Bucky is somewhat thinner in its construction than the curved one. This allows the patient to be in closer proximity to the film, and so eliminates some distortion and this increases the detail. The Bucky with its grid operates between the patient and the film.

Stationary Grid

A later development of a grid was made by Lysholm of Sweden utilizing the immovable form. This new grid does not replace the Potter Bucky Diaphragm but it is an excellent supplement, as it offers new possibilities in the field of diagnosis. This Grid is small and easy to operate, and is operated the same as the Bucky Grid, between the film and the patient. This new type of grid reveals very fine faint grid line marks on the film but usually such lines do not interfere when making an analysis or diagnosis of the case from the film. While it is usually preferable to move the patient to the X-ray laboratory and X-ray the case there, using the Potter Bucky Diaphragm, the condition of the patient or the present transporting facilities may prevent his being moved. However, by the use of the stationary grid a satisfactory view may be obtained to a great advantage to the doctor as well as the patient. This type of grid may be purchased thru any of the X-ray accessory establishments.

One may further increase the percentage of high quality spinographs or radiographs, particularly in the heavier parts of the body, by using radiographic cones or cylinders in connection with the Bucky Diaphragm or Stationary Grid. These cylinders and cones are made of either highly polished

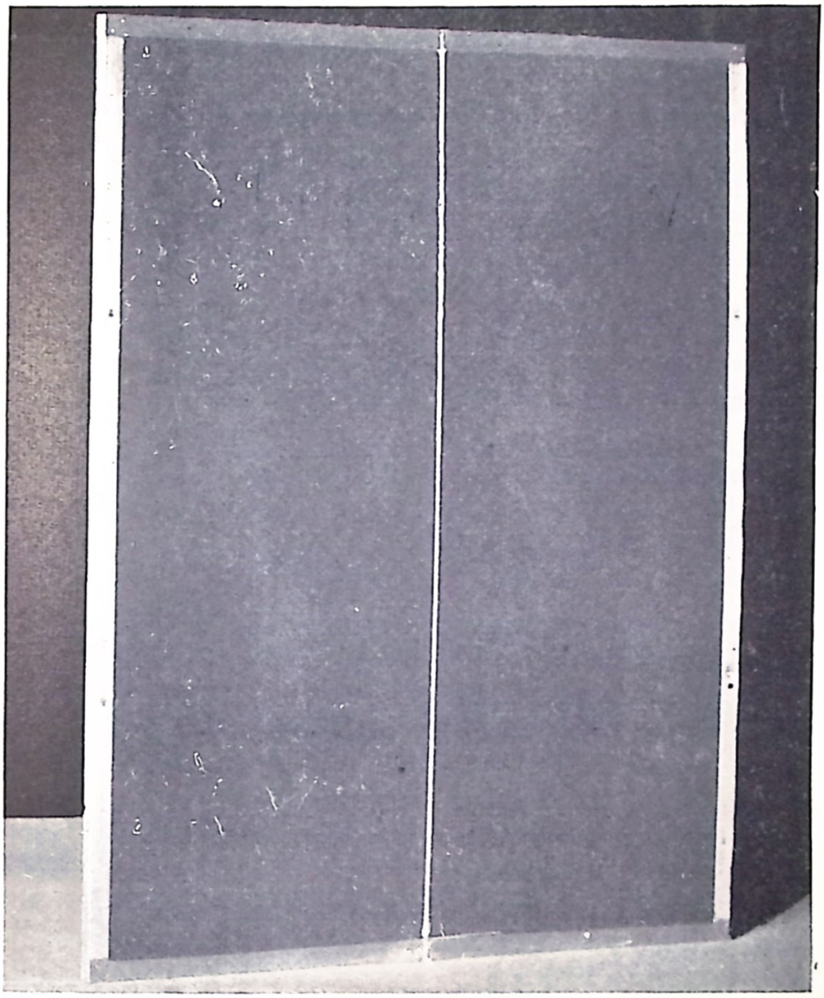


Figure No 9
Stationary Grid

metal or glass. When made of metal they are lined with lead. If made of glass there is sufficient lead in the glass to be the equivalent of 1/16 inch of lead.

The value of these accessory pieces of apparatus is far greater than many technicians realize, evidenced, I believe by the comparatively few laboratories that are equipped with the proper kind and types available. Perhaps this oversight is not due to lack of ambition, but rather a lack of

WARNING!

It is dangerous to operate X-ray equipment when certain established factors are not **strictly** observed.

Adequate precaution must be exercised at all times to prevent electrical shock and injury from X-radiation.

appreciation as to what these accessories really accomplish. The purpose of such cones and cylinders is to limit the amount of tube radiation itself, thereby reducing the angling radiation to the patient and the secondary rays to the film. This results, as the experienced spinographer knows, in an improvement in spinographic or radiographic quality, for it is obvious that the more secondary radiation eliminated—the better the radiographic quality.

What actually happens when using cones or cylinders is simply this — the area irradiated by the primary beam or path is limited to a smaller size so if the quantity of angling and secondary radiation given off is, in a sense, proportional to the port of entry of these rays—the amount of secondary radiation available to fog the film is materially reduced. It must be understood that certain sized apertures of cones or cylinders at its out-port, as well as in-port, must be used to cover a certain area at a given tube distance.

Spinographically, this is particularly true in making tube shifts in stereoscopic work. Such a cone should be approximately 2 inches at its in-port, when placed approximately 4½ inches from the tube target, and approximately 6¼ inches at its out-port. Its length should be about 12 inches. A longer cone of this type would operate very inconveniently, even though it would perhaps increase radiographic results at stereo tube distance.

When using cones in connection with the Bucky Diaphragm one must increase the exposure time or current slightly. Perhaps better results are obtained by increasing the current, keeping the time down and making the actual exposure instantaneous. The latter method will greatly help to overcome motion.

Double Intensifying Screens and the Bucky Diaphragm, together with lead cones eliminate secondary rays and increase contrast and detail on the film. Therefore, to provide oneself with proper and modern equipment, employing the use of the Double Intensifying Screen technic, Bucky Diaphragm, and accessories will increase results many fold.

CHAPTER 8

RADIATION

Soft rays are of little penetrative value and are produced when using the soft tube technic, such as a low spark gap or lesser amount of Kilo-Volt-Peak or penetration with an increase in time. Although this soft tube technic gives one a more mellow, white and gray film, providing the object can be kept motionless, it is sometimes harmful to the patient, especially when he or she has had recent X-rays. This is particularly true of the blonde individual. Blondes seem to be more susceptible to X-ray dermatitis and burns than brunettes. Too many consecutive X-ray exposures will often cause a patient's hair to fall, a condition commonly known as alopecia. Naturally, it behooves the X-ray operator to try to determine the number of recent X-ray exposures the patient has had totalling the M.A.S. limit before deciding his technic. Patients having had recent X-rays should wait at least a week or ten days from the time of the last exposure before having more films taken.

A piece of aluminum approximately 6 x 6 x 1/16 inch thick, placed just beneath the X-ray tube, will filter out many of the soft rays, however there may still be enough soft rays, penetrating the filter, to become detrimental to the patient if proper technic is not used.

Hard rays are produced when using the hard tube technic such as a high spark gap or more Kilo-Volt-Peak or penetration, with less time or more milliamperage. This type of technic is used in cases of muscular incoordination, children, or in very nervous individuals, who find it difficult to remain still. It is also used for patients who have had recent X-rays. The contrast and detail in the film may not be as distinct as that produced with the soft tube technic, but the danger of burning the patient seems to be eliminated by doing the work instantaneously.

Secondary rays travel in all directions, and are produced when X-rays meet with resistance other than lead, granite, etc. Lead being opaque to the rays, naturally absorbs them. The speed and penetrative power of the secondary rays depends upon the amount of force or voltage used in the production of X-rays. Secondary rays not only fog films, but are very detrimental to the health of the operator. He should protect himself when in constant exposure to these rays by working behind a lead screen or preferably in a lead lined room. When making fluoroscopic examinations he should wear lead gloves, lead goggles and a lead apron. Units on the market today are equipped with a lead glass bowl which envelops the X-ray tube and with shields, and even the tube oil immersed for the purpose of eliminating stray radiation, it still does not afford complete protection to the operator.

Secondary radiation is not only a menace to the X-ray operator but is very injurious. It is important that the technician learn all he can concerning such rays. The National Bureau of Standards can furnish additional information on the subject.

CHAPTER 9

QUALIFICATIONS FOR A SPINOGRAPHER

Individuals who are desirous of becoming spinographic technicians, should not only have some knowledge of electricity and photography, but should also know the structure of the human body. They may be either male or female. Their physical condition, is a very important factor, as X-ray work may or may not be detrimental to one's health if all proper precautions are not considered and even then it takes a very strong constitution to withstand consecutive exposures daily.

Perhaps one of the greatest essentials to any line of endeavor is character. Will power and self control play an important part, and so for the individual with a good character, health and a willingness to work there is always a future.

The X-ray technician must inspire confidence and have an unlimited amount of patience, for kindness, courtesy and diplomacy must be used at all times in the presence of patients. Such qualities are always expected of our profession and as the patient may want similar work done in the future, the actions of the technician may contribute much to the success of future X-ray examinations (or analyses).

WHAT CONSTITUTES A GOOD SPINOGRAPH

There are various opinions as to what constitutes a high quality radiograph, but there should be no difference of opinion in regard to the part that distortion, detail, and density play in getting clear-cut flats or natural, stereoscopic spinographs.

Some operators prefer dark films which obviously could only be analyzed before a very high powered light, while others prefer lighter films.

At no time should one attempt to read an X-ray film by holding it up to an ordinary room light or even sunlight.

Illuminators with rheostat lighting are specially constructed for this work.

A dark negative will not reveal certain, definite points or parts necessary in spinal reading. No doubt, there are other difficulties in respect to dark films. Certain lines of demarcation are eliminated by dark films.

As an experienced analyst, the writer's opinion of an acceptable flat or stereo-spinographic film includes a combination of the following factors; a minimum amount of distortion, correct placement, proper density, sufficient amount of detail, and contrast with clear cut outlines. In other words, he prefers a rather light colored film having a dark gray background with outlines white and clean cut. This type of film offers more definite information and so makes possible better results.

DISTORTION

Distortion as applied to the X-ray film means the twisting, turning, rotating, or a variation from the natural true shape, or size, of a bone, an organ or of any other structure which may appear on the film. Distortion, when seen on the spinograph film, may mean an increase in size of the vertebral segments, or, intensification of the degree of subluxation, rotation, misalignment or curvature. Distortion due to improper tube distance, produced when the object is not in close proximity to the film may not be considered so detrimental, but when it is caused by either tube or patient being out of alignment with the film, then an analysis or listing can not be relied upon.

To locate foreign bodies, distortion must be eliminated or their true position could not be ascertained by the surgeon. Any attempt to analyze the upper extremity of a full spine, (8 x 36 or 14 x 36 inch films) would in all probability cause the reader much difficulty. Quite often erroneous remarks are made pertaining to exostosis, ankylosis, rotation or other directions in the misalignment because of the distortion in the film due to its extreme angling rays.

DETAIL

When all the contour lines of the object appear, and when the lines of the hard compact structures of the bone are white, clear cut, sharp, and distinct, then the detail is said to be sufficient. When these lines are more or less hazy and indistinct, the detail is not complete. The same factors that control distortion, i.e., the distance of the object from the film; the distance of the focal spot from film; the alignment of the object; the film and focal spot; non-movement of the object, film or tube during the exposure; the film itself in perfect contact with screens; the use of the Bucky Diaphragm and cone are often important in perfecting detail. However, the bucky diaphragm, intensifying screens, and perhaps the faster speed film tend to distract from detail. When possible use cardboard holders, slower films, fine focus tube and a soft tube technic for greater detail. It must be remembered, however, that physical conditions and greater thickness of patient make it difficult and many times impossible to use all these factors and get sufficient detail.

CONTRAST

Contrast refers to the amount of difference between the extreme black and white over the entire exposed film area. The factors controlling contrast are voltage, time, milliamperes, fast screens, cone and Bucky Diaphragm. If the voltage factor is increased, the milliamperes or time factor is decreased, and there will be less contrast (if all other factors remain equal). As the voltage factor decreases, the milliamperes, or time factor increases, and there will be more contrast (if all other factors remain equal). Fast screens make more contrast.

Tube distance is not ordinarily used to control contrast because it introduces changes in distortion and detail. The quality or make of film does have something to do with the amount of contrast, yet it does not control it. The developing solution, developing time and temperature may be

so arranged as to allow the contrast, but is not considered a practical way to control it.

DENSITY

Radiographic density refers to the general density of the entire film towards a lighter or darker appearance. The degree of density cannot be fixed as a permanent quality for it is largely a matter of individual preference. Time, tube distance, milliamperes, or voltage may be used to change the density. Tube distance is rarely used because of the elements of distortion. Increasing or decreasing the milliamperes may also affect density, but this factor is not ordinarily used to control it, due to the size of the smaller focal spot or lined tubes. Ordinarily, the factors used are time and voltage. To increase or decrease time and voltage will respectively increase or decrease the density. It is well to remember that the developing procedure will tend to control contrast. When the film is over-exposed, the developing time must be shortened to get a readable film. Experience proves that better results are obtained by arranging the machine technicalities so that the films may develop in efficient solution of proper temperature a full five or six minutes, depending on the type of film manufacture.

Density varies directly and proportionately as to the milliamperage—directly and proportionately as to the exposure time. This means exposure time and milliamperage are interchangeable. Density varies directly and nearly in proportion to the square of the kilovoltage and inversely as the square of tube distance.

PLACEMENT

The consideration of the proper placement of patient and tube for a satisfactory spinograph is a very important factor. It is so important that if placement is not correct the analysis is usually incorrect.

The general detail may be very good but if a certain procedure is not carried out in posture the film becomes of little value. This is particularly true in Chiropractic work as spinographic conclusions must be reached by comparing certain outlines of spinal segments with one another, with patient placed in a normal relaxed position.

It is interesting to know that an improper placement of patient or tube may cause the drawing of incorrect plane lines and wedges on the film and therefore result in an erroneous listing. No doubt this is the direct cause of many border-line failures.

CHAPTER 10

THE CHIROPRACTIC STEREOSCOPE

The stereoscope, as applied to spinographic work, is an instrument so constructed that the spinographer may obtain a depth perspective of the region he chooses to analyze. In other words, the third dimension may be optically realized. Heretofore, stereoscopic work consisted mainly of chest, pelvis, hips, skulls, etc. Through Chiropractic research we are able to stereoscope the spine, particularly the upper cervical region, with amazing results.

Construction

The construction of our stereoscope consists of two 8 x 10 illuminating boxes, facing one another, each having a 100 Watt blue bulb and an opal blue glass. These boxes slide on two parallel nickel rods, suspended by two end-brackets. At a central point between these two end-brackets is placed a pair of mirrors with an angular and tilting adjustment for the accommodation of the spinographer's or Chiropractor's eyes. This is referred to as the center assembly. The reflection in the mirrors of the two images on the films with the proper procedure brings out an optical effect whereby the eyes view the spinographs as one image with depth.

THE VALUE OF THE STEREOSCOPE AND PROPER EQUIPMENT

The use of the stereoscope in the practice of Chiropractic is not a fad, but an absolute necessity if one wishes to render the best possible Chiropractic service in getting sick people well. The importance and value of the X-ray to the profession from an analytical standpoint has been constantly increasing since the discovery of X-rays by William Konrad Roentgen of Wurtzburg, Germany, December 28, 1895. Those who are engaged in this work realize its great importance, and that it will continue as time goes on.

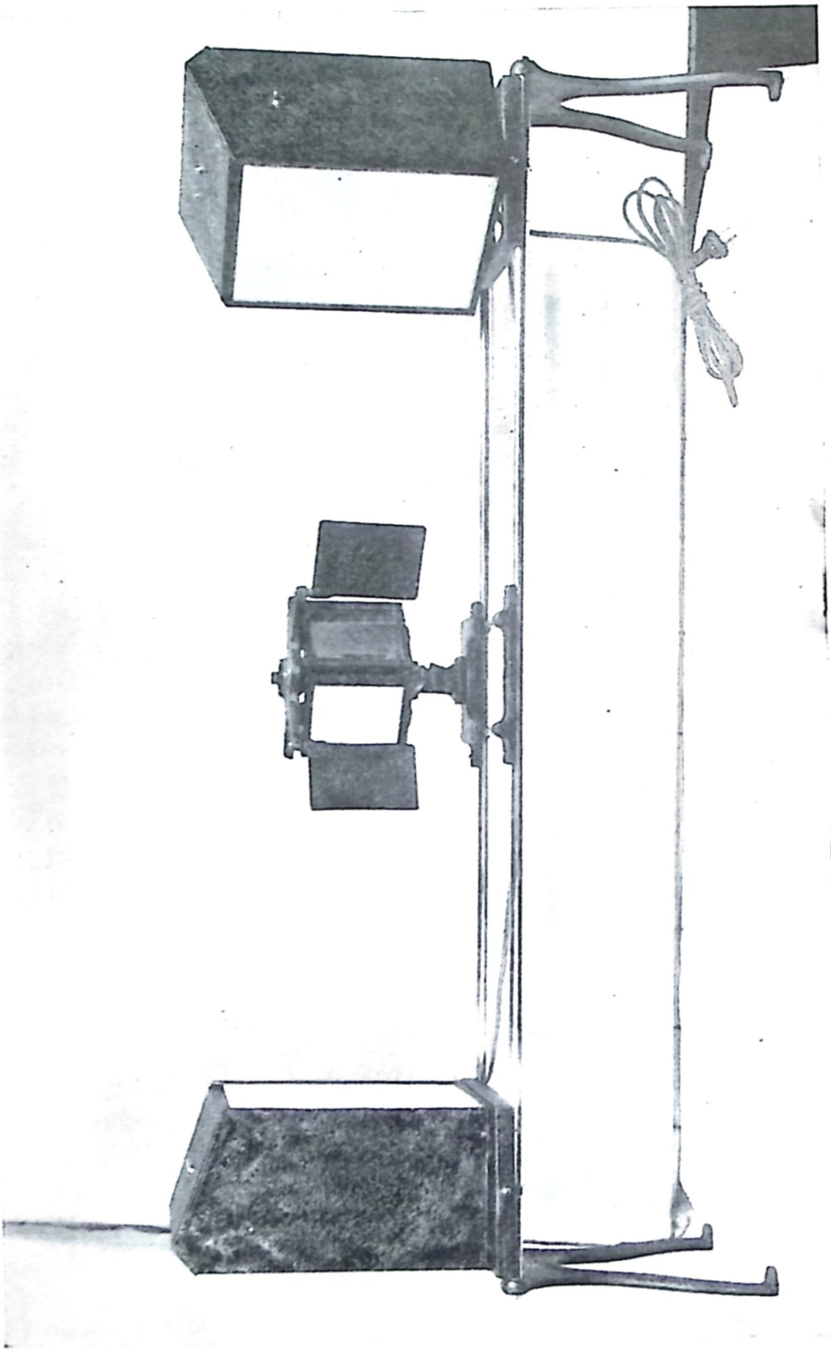


Figure No. 11 Stereoscope (8 x 10) for Chiropractic Purposes

Medics insist on the X-ray, many times demanding the stereoscopic work, admitting that they cannot see with their fingers. Altho dentists seldom use the stereoscope they rely upon the X-ray to locate defective and abscessed teeth. Medics and dentists who think the X-ray a fad or a thing unnecessary are considered out of date. Now the time has come when the Chiropractor is being judged in the same manner.

Medically speaking, X-ray is one third of a diagnosis, as case history and a physical examination are used to complete the process. It might be said that in Chiropractic, Spinographs, Neurocalometer reading and that part of case history pertaining to accidents and high temperatures are needed to complete the spinographic analysis.

When a Chiropractor insists on a spinograph of every case, particularly the stereoscopic type, he is looked upon as being a more thorough practitioner. IT IS A PHYSICAL IMPOSSIBILITY TO CONSISTENTLY PALPATE A SUBLUXATION CORRECTELY, or any misalignment existing within the spinal column.

Chiropractors can improve their service by stereoscoping every case as this consistently better reveals the vertebrae in their misalignments. It reveals just how the rotation, anteriority, superiority or inferiority and side-slip or laterality are causing the subluxation, and whether there is dissymmetry in development, fractures, dislocations, or whether pathology is present. Seeing is believing, and a spinograph if properly made, never fails to reveal what there is to see. It is one of the greatest aids to our profession.

Each Chiropractor should have a modern X-ray machine with necessary equipment in his office. It will give him more confidence in himself; and too, it promotes efficiency for a practitioner to have access to such equipment at all times, instead of having to refer patients to some Spinographer or practitioner less competent along these lines. This equipment in your office always has a decided psychological ef-

fect upon your patient, and especially is this true, when consulting prospective cases.

Because of the inability to correctly palpate the laterality of the spinous or body of axis, including its pivots, or a High or Low condyle, the atlas with its Anterior-Superior, or the Anterior-Inferior anterior arch or the Atlas rotation, it becomes necessary to spinograph. A Lateral, an Anterior to Posterior flat view, Anterior to Posterior Stereo and Vertex Stereo views are usually needed to decide the true position of the Atlas and Axis with one another and their relation to the occiput and the 3rd cervical. Bent spinous processes, exostotic growths, ankylosed conditions, long and malformed transverse processes, vertebral pivots and curvatures all make it difficult to palpate the spine correctly.

Years ago we experimented with and talked of the advisability of spinographing in the upright position but not until the stereoscopic Atlas-Axis specific became a working practice, did we actually realize the full importance of the upright, normal relaxed posture. Much experimentation was carried on and finally the conclusion was reached that the patient sitting up, could and did assume a more normal, relaxed posture for spinograph exposures. Although the difference in the vertebral positions either in the prone, supine, standing or sitting postures seldom revealed the opposite misalignment or subluxation on the film, yet often it changed the occiput from a High to Low or vice versa, as well as degree of vertebral position in rotations, curvatures, etc.

Proper working equipment and correct technical procedures always make more information available, thus making the work more valuable to all.

CHAPTER 11

THE FLUOROSCOPE AND ITS PURPOSE

The standard fluoroscope is an instrument used for making fluoroscopic, or visual, X-ray examinations of the patient. It is commonly used for examining chest, gastro-intestinal tracts, fractures, and for locating foreign bodies. The best results are obtained when operating this equipment in a dark room. However, the hand fluoroscope, which snugly fits the operator's eyes, may be operated in a light room. This type is used when reducing fractures or attempting to locate foreign bodies.

Either the standard or hand fluoroscope may be used with the patient upright, standing, sitting, or lying—prone or supine.

The fluoroscope is of little value to the Chiropractor in determining a misalignment, or subluxation.

Construction

The standard fluoroscope consists of a frame work approximately three and one-half feet wide by six and one-half feet high, supporting a tube enclosed in a light-proof, lead glass bowl. The fluoroscopic screen is made in various sizes, and mounted in a frame covered with a lead glass plate, all of which may be moved up and down, or cross-wise to the patient. Between the tube and the patient is placed a partition of wood, bakelite, or aluminum fastened to the frame work, also there are lead shutters, which may be opened or closed at the will of the operator. The lead glass covering the screen eliminates most of the secondary radiation, so therefore, protects the operator's head, chest, and shoulders. But to afford complete protection to the operator against secondary and primary radiation, he should provide himself with lead-lined rubber gloves, lead-lined rubber apron and lead glass goggles. He should also be sure that the fluoroscope is grounded—to eliminate any possible static electricity.

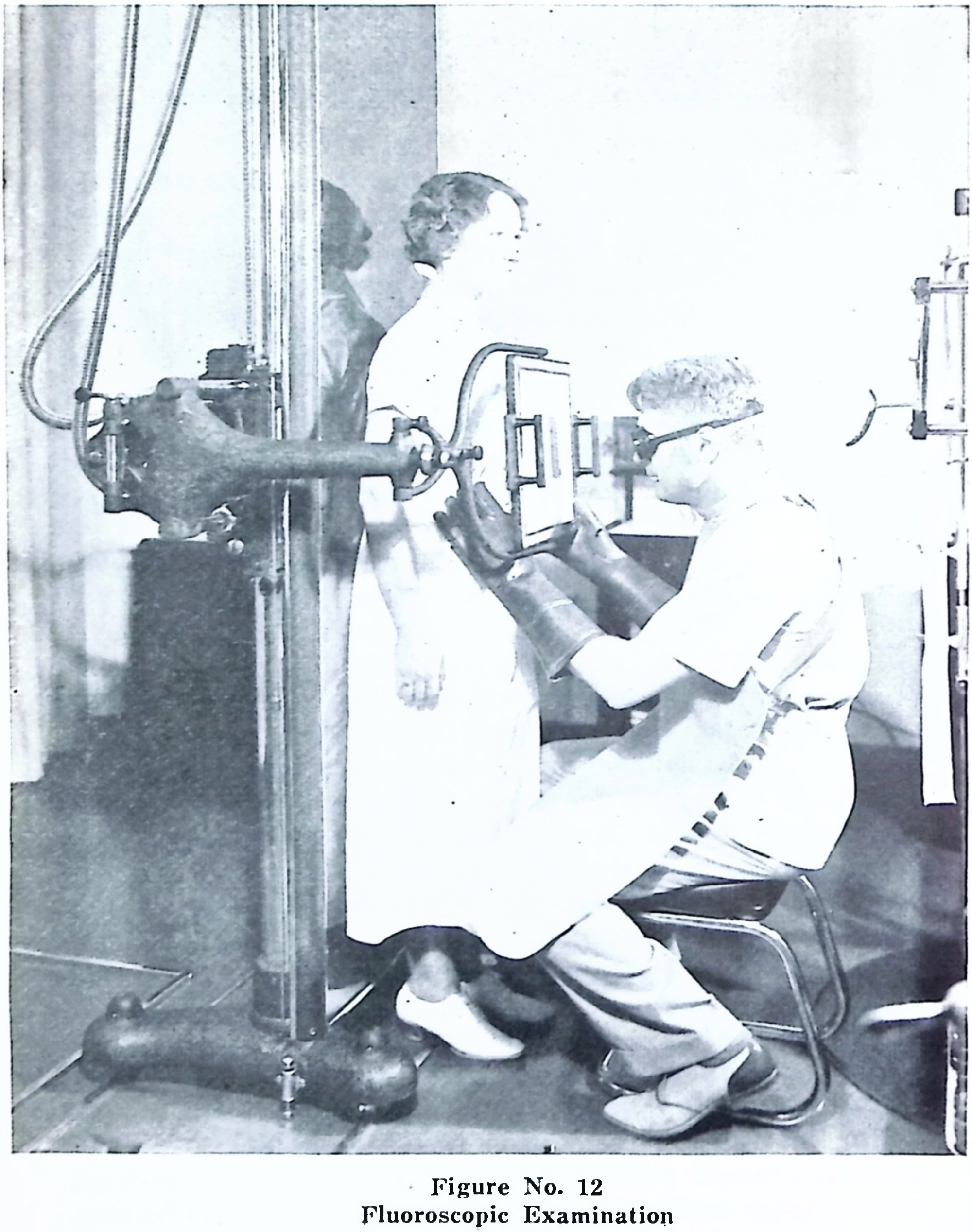


Figure No. 12
Fluoroscopic Examination

The patient is protected with shockproof equipment by the elimination of any static, by placing high tension wires out of his reach, and by using the proper technic in examination.

Intensifying screens cannot be successfully used for fluoroscopic purposes for they become too laggy and grainy, and so deteriorate too rapidly. The fluoroscopic screen deteriorates very slowly with use or from age.

The shutters used between the tube and the partition enable the operator to increase or decrease the size of the fluoroscope field. The smaller the field, the sharper the object and the finer detail obtained. Almost any type of Coolidge or Eureka focal or lined tube will operate within the fluoroscope, but the writer's opinion is that the 5-100 or 9-100 AL type line focus tube is the better one for fluoroscopic use. These types produce sharpness and very fine detail, which are of vital importance when making such examinations. The maximum voltage and milliamperage capacity available for a continuous operation with a 5-100 or 9-100 AL line type Eureka tube is 85 KVP—5 milliamperes at five minutes of time. From three to five milliamperes is ordinarily used in fluoroscopic examinations at from 75 to 85 KVP.

Fluoroscopic Room—Protection

The standard fluoroscope should be operated in a dark room, as ordinary light interferes with the visibility of the fluoroscopic image. Either red or green lights may be used for the required general illumination of the room, although a totally dark room produces the best results. The operator should remain in the darkened room, previous to the fluoroscopic examination, to allow the pupils of his eyes to fully dilate. Intermittent exposures aid greatly when increasing the life of the tube, and are less dangerous to the patient.

Never give more than twelve hundred (1200) milliampere seconds to any one area at approximately fifteen (15) inches target skin distance. It is also important to make

inquiries as to the patient's recent exposure to X-rays so that the safe dosage be not exceeded.

Always use an aluminum filter between the patient and the tube to eliminate the soft rays which may be detrimental to the patient. The usual thickness of the aluminum filter is one millimeter. When the maximum exposure is given it should not be duplicated under two to three weeks. Always see that the high tension wires (if not using shockproof equipment) are at a safe distance from operator and patient.

CHAPTER 12

DOUBLE INTENSIFYING SCREENS

Since the discovery of X-ray there has been a great demand for some means of reducing the radiographic exposure time. It is a known fact that constant contact with the X-ray is injurious to the operator, even though he employs modern protection other than operating in a lead-lined room. Also too many lengthy consecutive exposures may do great harm to the patient, so any possible reduction in X-ray exposure time will add to the safety of both the patient and operator, and too, it is an important factor in coping with motion. Motion on any X-ray film means the film is spoiled and of no value.

To meet this demand, highly sensitive films were made, but they too have received their share of criticism because those using the films failed to realize that the more sensitive the X-ray film became—the more sensitive they were to all causes of deterioration. This, however, is not true with intensifying screens, as the sensitivity of the screen's fluorescent crystals seemingly does not change a great deal with age. Therefore, it is evident that the road to a shorter exposure is through the medium of fairly fast, well-balanced, intensifying screens, rather than a faster, highly sensitive X-ray film.

The intensifying screen consists of a thin, pliable or flexible base—usually white cardboard—bound and coated with a solution of minute, calcium tungstate crystals which, when excited by the X-ray, will fluoresce in ordinary light. When these screens are in perfect contact with the film emulsion, the screen's fluorescence intensifies or aids the action of the X-ray.

Calcium tungstate is used in the screen emulsion because it not only gives off light of a desired quality of fluorescent rays, when excited by the X-ray, but it is also a stable

compound that seemingly does not deteriorate under the X-ray bombardment.

Purity of the calcium tungstate is of utmost importance, as it determines the quality of this fluorescent light, which should be composed of the maximum amount of blue, violet and ultra-violet rays.

When the calcium tungstate is pure, the exposed X-ray negative will then be free of a grainy appearance which would be due to an inferior grade of crystals, or of crystals which are too large. The wave length of the fluorescent light is said to be much longer than that of the exciting X-ray light. Suitable material must be used to hold the calcium tungstate crystals suspended. This material is called a "binder". The quality of this binder is very important as an inferior quality may turn yellow under continuous use or age. This causes the screen to become slow in its action, and may result in a film of little or no value.

The analytical or diagnostic value of the X-ray film necessitates the use of the best intensifying screens available, for after all, X-ray films are no better than the intensifying screens that make them with few exceptions. The fine qualities or the defects in the screen's emulsion invariably manifest themselves in the finished spinographic or radiographic film. It is not uncommon to find technicians of certain X-ray laboratories who frequently complain of a variation in the speed of the X-ray film used. Their true difficulty is probably due to a mixture of old and new, or slow and fast screens from various manufacturers. Hence the continual disturbance in one's technic. For if the screens are abnormally slow, one has to sacrifice speed of the exposure under conditions where it may often be an essential requirement. This increases the possibility of blurring due to motion, and results in wasted films and unnecessary wear on the X-ray tube.

Therefore the use of the same type of screen, new or old —fast or slow, from the same manufacturer, is very important, particularly in the stereoscopic work, since motion on

the spinograph or radiograph, produced in any manner, must be eliminated to properly fuse the films. Stereoscopic films must be as nearly identical as possible. There are several makes of intensifying screens made in slow, medium, and high speed types. Each type has more or less value. For instance, there are cases for X-ray which require work that must be done instantaneously. This necessitates a rather fast type of screen, instead of a slow one. On the other hand, there are cases which require more exposure time with certain type tubes. In these a slower screen may be used. However, screens too high in speed-value mean speed and no contrast, a very undesirable feature, particularly when X-raying deep tissue. Films of this type are flat, without depth and have the appearance of over-exposure. So the opinion now prevails that fairly high speed screens for general and all around work may be used to better advantage.

It is not ethical to discuss here which of the standard manufacturers make the better screens, for that may be largely a matter of opinion. But one should consider the manufacturer's reliability when selecting intensifying screens, as it is his reputation that you should depend upon in respect to a variety of physical defects which the ordinary X-ray laboratory's testing facilities will not detect until too late. The only practical method of testing screens for speed and contrast in your X-ray Laboratory, is by comparative exposures of heavy objects. Never attempt to compare sets of screens if one set is contained in a bakelite and the other in an aluminum front cassette, as the bakelite offers less resistance to the X-rays and so requires less exposure time.

In the construction of intensifying screens there are several features to keep in mind if the highest quality of work is to be done with them. These qualifying facts are grain, lag, speed, uniformity, contact and ease of cleaning.

Always avoid screens which are grainy due to the uneven size and distribution of calcium tungstate crystals. Such

imperfections may distort and even obliterate the fine detail of the spinograph.

Laggy screens sometimes possess an after glow and this results in radiographs of either a hazy nature or those which have the appearance of double exposure. There may be white specks or minute spots appearing on the developed film. These should not be confused with laggy screens. They are usually the result of dirty screens. To test for lag, place a small piece of coiled steel wire on the top or face of the cassette; the cassette containing no film. Expose as in the maximum routine work and immediately remove the cassette to your darkroom and insert an unexposed film. Allow the film to remain in the cassette in your darkroom for ten or fifteen minutes. Then remove the film from the cassette and follow the regular developing procedure. If an outline of the coiled wire appears on the developed film, it is positive proof that afterglow is prevalent and such intensifying screens should then be discarded.

Speed refers to the relation of the amount of X-ray density required by the films exposed with and without intensifying screens. For instance, given technic will produce a certain amount of radiographic density on a film exposed without screens, but the same density, using the same technic can be obtained on a film with intensifying screens in much less time. In other words, use of the modern double intensifying screens will reduce the time element perhaps six or seven times.

Uniformity depends largely on the high quality of chemicals used in the screen's emulsion, and an evenly divided fluorescence over the entire screen's surface. This is very important, for many of the cheaper screens today will be found to have so-called "dead spots". But if screen contacts are good and the fluorescence is evenly distributed, the darkened areas will be uniform on the film.

Screen contact is likewise important; it refers to the proximity of the screen and film surfaces. Improper contact is, perhaps, either the result of screen mounting, or the

use of an inferior grade of cassette or both. Poor contacts will result in haziness or fuzziness appearing on the developed film, which materially affects the film detail. Motion of the patient or tube is often blamed when the difficulty is actually poor screen contact.

To further increase film results, keep screen surfaces clean — free from dust particles and the splattering or splashing of the darkroom chemicals. Dust particles will embed themselves in the screen emulsion if screens and cassettes are not brushed out daily, and result in white specks on the negative. A soft camel hair brush is advisable for this purpose.

Intensifying screens represent many a dollar to the commercial X-ray laboratory and so great care should be exercised in preserving the emulsion on the screen's base. Avoid finger prints and handle the screens only by their extreme edges. Do not draw or slide the film over the screen's surface, as this will not only scratch and eventually deteriorate the emulsion, but it will also produce static and the films developed will reveal fine black lines.

When a cassette is not in use it is advisable to place in it a piece of thin, white, clean cardboard or tissue paper, then close its cover. This will not allow the screens to come in contact with one another and also it will keep them free from dust and dirt.

It is not advisable to pick the film out of the cassette, for this will often peal off part of the emulsion, destroy the crystals, and place the screen in the path of destruction.

As all up-to-date screens are made washable, dirt or even wet solution spots may be removed without material injury to the screen surface. A tuft of cotton, Ivory soap and a small amount of lukewarm water will remove the dirt. Wet chemical spots may be immediately removed with a tuft of cotton saturated with peroxide, but if such spots become dry, nothing will remove them, without injury to the screen's emulsion.

The best results in drying screens are obtained by using

a piece of cotton and then placing them in the sunlight. The sun will not only dry, but will also tend to bleach them. Be sure the screens are perfectly dry before attempting to insert the film, as tacky screens will adhere to the film emulsion and result in not only a poor film, but will also break up the calcium tungstate crystals and so ruin the screen.

The mounting of screens is simple, yet it must be carefully done. The two screens are mounted with pieces of adhesive, one placed on the cover and one on the bottom of the cassette — with the screen's surfaces facing one another. This procedure should be arranged so that screens will make a perfect contact with both sides of the film.

CASSETTES

The cassette is a device in which two intensifying screens are fastened; it carries the film throughout the exposure, thus keeping it light proof. A cassette can be had in either the aluminum or bakelite face, the latter, however, offers less resistance to the X-rays.

It consists of a frame, cover, and cover hinges. Felt lining is placed on the inside of the cover and around its edges. This produces better contact of film and screen and eliminates all possibility of the film becoming fogged, because of ordinary light leakage. Springs, usually two in number, are fastened to the outside of the cover to lock it with the frame and to further insure better contact and prolong the life and efficiency of the screens.

Perhaps the hollow steel frame is superior to the aluminum frame casting, for the aluminum type often cracks or loses its shape when it is accidentally dropped or in rough usage. Also the hollow steel frame cassette is dye-formed and produces perfect alignment. It represents strength and rigidity and should last indefinitely.

CHAPTER 13

X-RAY FILMS

There are many manufacturers making X-ray films which ordinarily present good diagnostic and contrasting negatives, for with competition as keen as it is, all film manufacturers are forced to turn out a standard quality product.

So, generally speaking, all X-ray films are good. They are made in large rolls and cut for use. The popular sizes are the 8 x 10, 14 x 17, 8 x 36, and 14 x 36. The 18 x 40 size can be had but at the present time is made up for special order.

For Chiropractic purposes the technician is not desirous of contrast but a clean-cut film with sharp outlines. That is to say, a film revealing less black and white contrast, and more white and gray with thin white outlines satisfies, for the Chiropractor compares vertebral outlines. To meet other demands, shadows within shadows, or areas within areas are sought.

Negatives too dark obliterate certain definite points which the Chiropractor is most vitally interested in; also a film too light is of no value. It is the medium type that offers him the best results.

Films presenting speed, a certain amount of contrast, freedom from chemical fog with absolute uniformity have the outstanding points required by the Chiropractor. It is said that the geographical location of such a plant plays an important part in the making of the film emulsion as a certain kind or quality of well water must be used. If certain impurities are found in the water, the gelatinous emulsion will absorb them. This causes films to take on a muddy or smoky appearance. Therefore, the better the water supply, the better the quality of films.

In the processing of X-ray emulsion, certain foreign chemicals are formed in the emulsifying of the silver. If these chemicals are not entirely removed during the wash-

ing process, fog, and a poor keeping quality will result. Film speed is dependent, to a large extent, on the keeping quality.

The silver bromide crystals, which should be very fine, will aid in the registration of contrast and the most delicate detail. They also resist, to a considerable degree, the softening effect of warm wash water.

Film deterioration is largely the result of exposure to heat and moisture. It is not advisable to carry too great a film supply during the summer months or heated periods and those on hand should be kept in a cool, dry place.

Film difficulty is more noticeable in faster than in slower speed films. During the past few years the speed of X-ray films has greatly increased and complaints due to deterioration have become more noticeable.

Often deteriorated films may be processed, with some success, by slightly reducing the normal exposure and developing them in a solution a few points less than the average developing temperature of 65 to 68 degrees Fahrenheit.

FILM DEVELOPING HANGERS

Film developing hangers are an important part of one's equipment and are used more often than other dark-room accessories. Therefore, they should be substantial, practical, free from corrosion, and conveniently placed for loading.

It is not advisable to attempt to develop X-ray films of 8 x 10 size or larger by omitting the hanger and using the small dental clips. Such a procedure will, in all probability cause finger prints—sometimes to the extent of losing the emulsion at that point on the film. It promotes the appearance of blisters on the finished product and results in a very unsatisfactory unprofessional looking negative.

Hangers are made in long and short bar types for the purpose of fitting almost any developing tank on the market. The bar itself refers to the top piece which keeps the films suspended in the solutions. A special type is now manufactured with attachments for both the 8 x 36, 14 x 36 and

the 8 x 10 size film. Processing of these may be made at the same time.

A developing hanger consists of a bar, a frame, two springs, and four to eight clips, or more as the need may be. The life of a developing hanger will be considerably increased if the water in the wash tank is allowed to completely submerge the hanger during the film washing process. Developing hangers should occasionally be submerged in acetic acid which will remove all corrosion.

CHAPTER 14

X-RAY TUBES AND THEIR ACCESSORIES

There are many types and makes of X-ray tubes on the market today. For like all business concerns there are constant changes, so while some factories cease producing others are being established. Hence it really is a struggle for existence and a survival of the fittest in this market as it is in all others.

X-ray tubes of this country may be classed as follows:

1. Radiator Radiographic Tube
2. Radiator Dental (Right Angle Tube)
3. Oil-immersed Tube
4. Universal Tube
5. Air-Cooled Deep Therapy Tube
6. Water-Cooled Deep Therapy Tube
7. Ray-Proof Shield Tube
8. Rotating Anode, either air-flow or oil-immersed.

In this chapter consideration will be made only of the type of tube ordinarily used for radiographic purposes. This will be done in a general way to merely acquaint the student with its manufacture and construction, as well as the operation of the X-ray tube itself.

There are two things that must be considered in the operation of any X-ray tube. First, the proper supply of electrons and second, the proper electric current to force the electrons against the target. These two must be so closely related that a proper voltage or penetration may be maintained when the current is actually applied.

Perhaps the first efficient tube made, to be successfully used in bone work, was the Coolidge tube, a trade name. It was produced by the Victor Corporation which later sold out to the General Electric Company. It was so named in honor of its inventor, Dr. W. D. Coolidge, then of the Re-

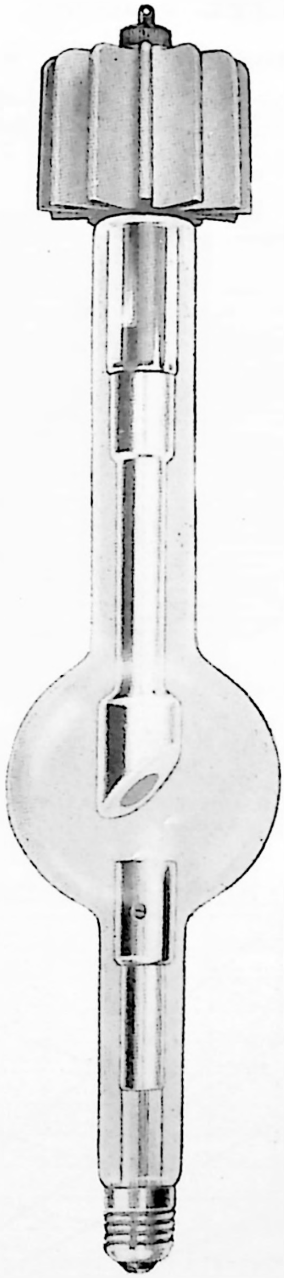


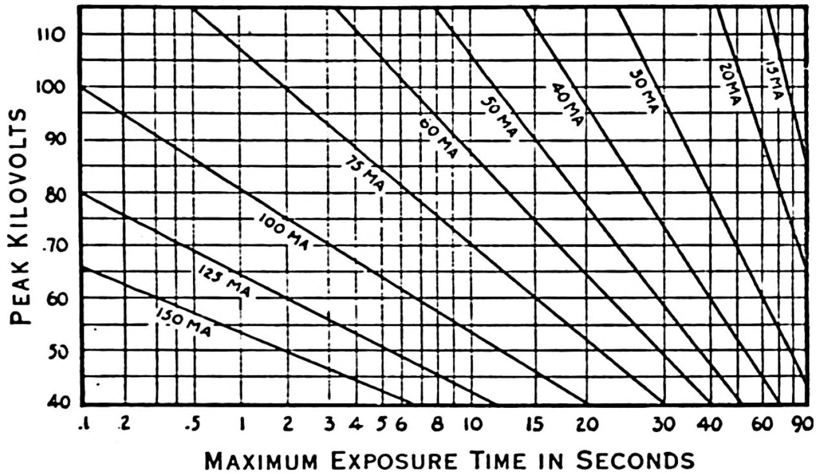
Figure No. 13
Line focus radiator type X-ray tube

TYPE 9-100AL

For General Radiographic Technic

9/64 inch projected focal spot—100,000 heat units—(heat units are Kv.P. x Ma. x seconds)—Air cooled—Line focus.

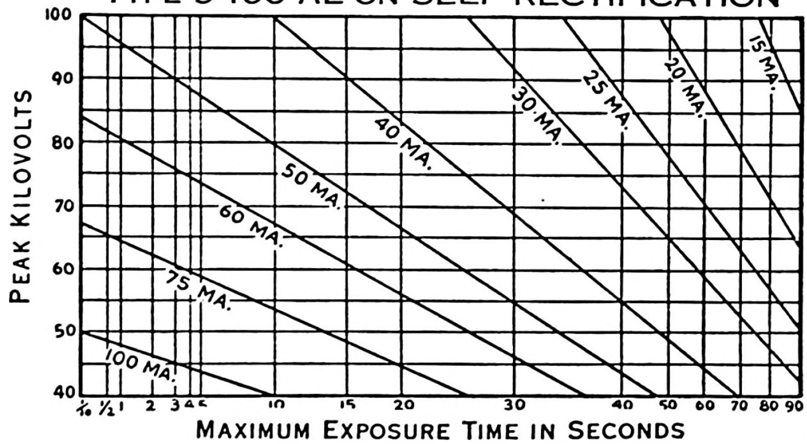
TYPE 9-100 AL ON FULL WAVE RECTIFICATION



Examples: 100 Ma., 75 Kv.P., 2 Sec. 30 Ma., 85 Kv.P., 37 Sec.

NOTE: Fluoroscopic Rating for all types of rectification 85 Kv.P., 5 Ma., 5 Minutes.

TYPE 9-100 AL ON SELF RECTIFICATION



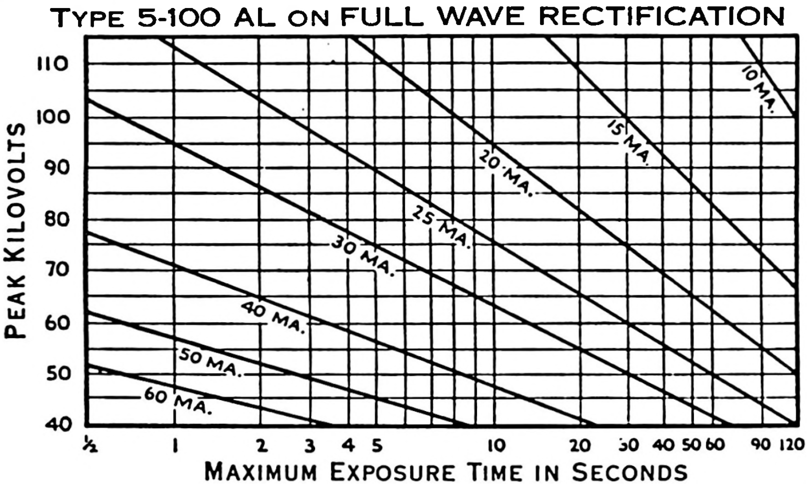
Examples: 50 Ma., 80 Kv.P., 10 Sec. 30 Ma., 90 Kv.P., 32 Sec.

Figure Nos. 14 and 15
Non-Shock Proof Tube rating

TYPE 5-100AL

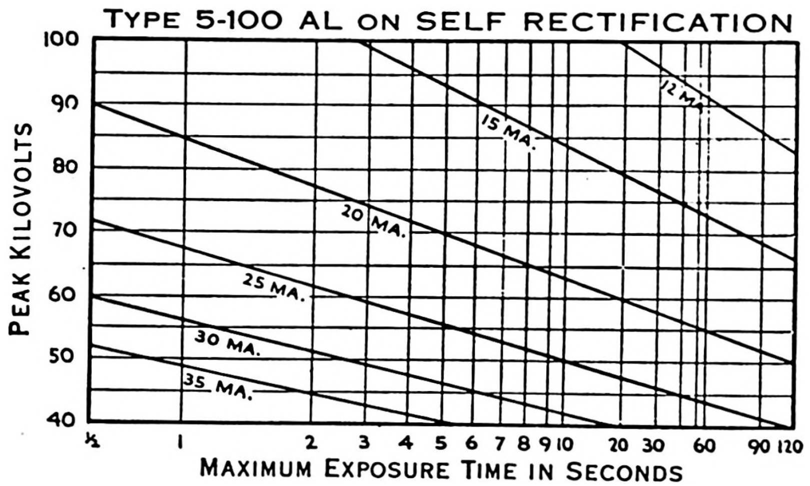
For Fine Detail and Fluoroscopy

5/64 inch projected focal spot—100,000 heat units capacity—(heat units are Kv.P. x Ma. x seconds)—Air cooled—Line focus.



Examples: 20 Ma., 65 Kv.P., 50 Sec. 30 Ma. 65 Kv.P., 9 Sec.

NOTE: Fluoroscopic Rating for all types of rectification 85 Kv.P., 5 Ma., 5 Minutes.



Examples: 20 Ma., 60 Kv.P., 20 Sec. 25 Ma., 50 Kv.P., 10 Sec.

Figure Nos. 16 and 17
Non-Shock Proof Tube rating

search Laboratories of General Electric Company, New York. It was first placed on the market in 1912; since that time many other tubes for such use have come into existence.

During 1919, the Eureka X-ray Tube Corporation was founded in Chicago, Illinois and today it is perhaps one of the leading manufacturers of radiographic tubes.

These two so-called makes of tubes are similar as each has a hot cathode, so no distinction will be made between the tubes or manufacture of hot cathode tubes.

Hot cathode tubes consist of a glass bulb with two arms extending in opposite directions. From about the center of the bulb, through one arm to its end, is the anode assemblage, the cathode parts extending in the same manner through the other arm.

Some types of air-cooled tubes operate with a disc radiator on the anode (or positive) end of the tube to disperse the heat. In some the heat is eliminated through its large glass bulb. In still others of the oil immersed type, the tube is kept cool by its oil.

This type of tube, the hot cathode, is self-rectifying as long as the target does not get too hot. Incidentally in radiographic work the use of current up to 90 K.V.P. should not overheat the tube.

Principle of Operation

The hot cathode tube has a very high degree of vacuum. It operates by means of electrons emitted from a heated filament which number in proportion to its temperature.

If a high potential is applied to the tube a stream of electrons is made to travel towards the target or anode end of the tube at a tremendous speed, the speed being determined by the velocity of the current applied. This stream, known as the cathode stream, is directed to a focal point on the face of the target, the size of which is determined by the design of the cathode and anode of the tube. The abrupt stopping of this stream results in the production of X-rays

which radiate in many directions from the focal point of the target.

Direct rays are those which emanate from the focal point practically downward.

Angling radiation is that which flows out, angling laterally from the direct path but which eventually follows the angle of the tube target. This angle now ranges from 15 to 22 degrees, and perhaps slightly more. Some manufacturers differ in forming this particular angle. However, a 22 degree angle seems to give very good results.

Stray rays are those directed from target other than focal line.

Line Focal Spots

The line focal or rotating anode tube is best for radiographic purposes, at least its results are very satisfactory. More energy may be used in these line focus tubes but it still maintains that fine definition provided by the smaller projected focus. The fine effective line focal spots are as follows:

Rotating Anode — perhaps the finest definition. Focal width 1 M.M.

Type 3-100—Fine definition. Focal width 1.5 M.M.

Operating on self-rectification. Maximum technic 10 M.A., 80 K.V.P, for 120 seconds or 1200 M.A.S.

This tube is ideal for all extremity work and the spines of very thin individuals. It provides the maximum detail in radiographs and spinographs or on the fluoroscopic screens.

Type 5-100—Detail and speed. Focal width 2 M.M.

Operating on self-rectification. Maximum technic 30 M.A. 85 KVP, for 12 seconds or 360 M.A.S.

Obviously this width of focus offers very good detail and permits the use of more milliamperes. It is perhaps the better tube for ordinary spine work and yet stereoscopic work is permissible.

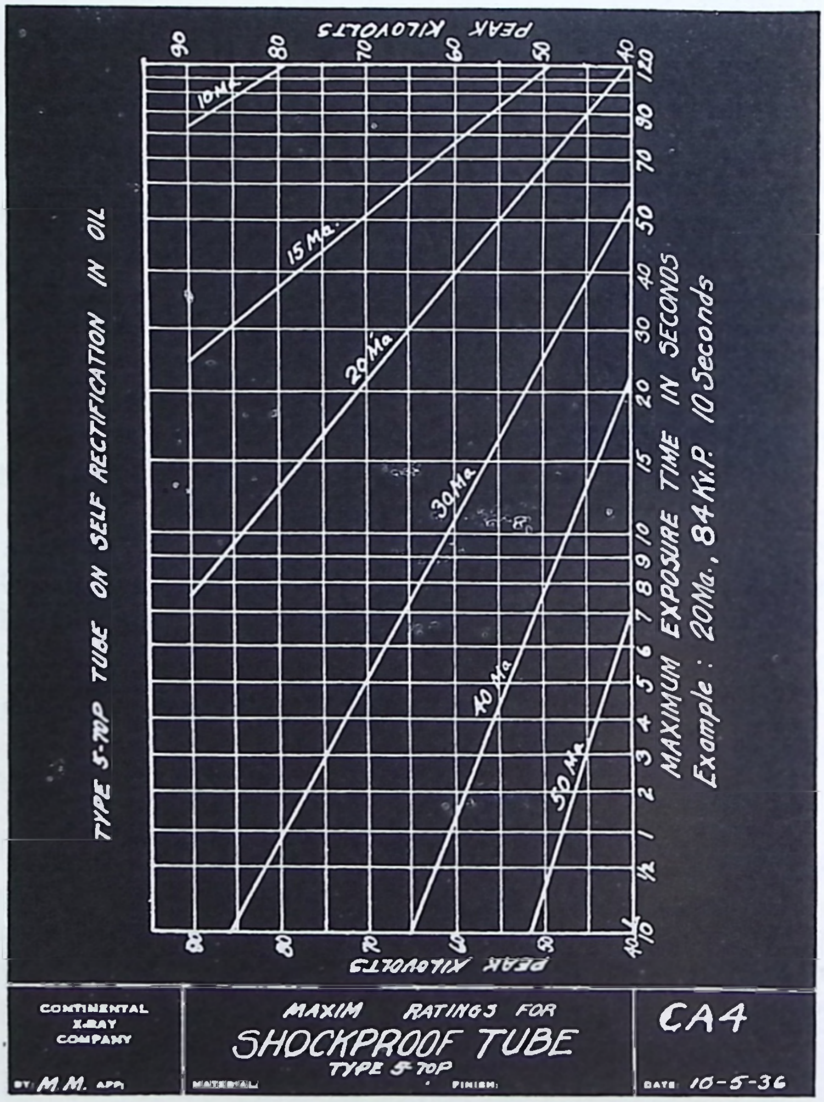


Figure No. 18

Tube (shock proof) rating. Type 5-70 P (5-100) self rectification

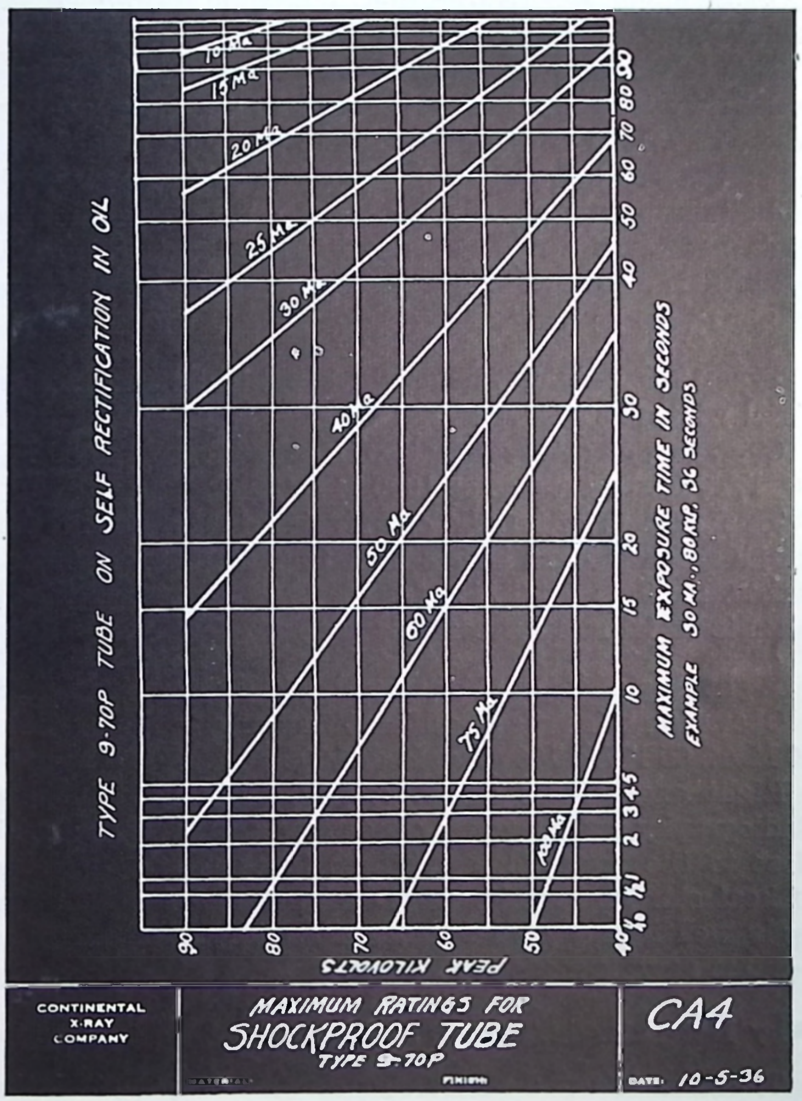


Figure No. 19

Tube (shock proof) rating. Type 9-70 P (9-100) self rectification

Type 9-100—General radiography. Focal width 3.5 M.M.

Operating on self-rectification. Maximum technic 50 M.A., 80 KVP, for 10 seconds or 500 M.A.S.

This tube seems to be the choice for general radiography and heavy spinographic work used in the average X-ray laboratory. It is no doubt, the more practical tube for Chiropractic purposes (other than the rotating anode) when instantaneous exposures are necessary. It permits the heavy loads necessary for Chest, Stomach, and entire Intestinal track. It is also used in Stereoscopic procedure and a series of films may be made.

Type 12-100—High milliamperes and instantaneous work. Focal width 4.8 M.M.

Operating on self-rectification. Maximum technic 50 M.A., 80 KVP, for 20 seconds or 1000 M.A.S.

This tube is especially constructed for speed in radiographing chests and hearts at a tube distance of 60 to 72 inches. It offers detail, is of a very high heat capacity and permits serial and stereoscopic exposures.

Right Angle Tubes—Very fine detail. Focal width 1.5 M.M.

Operating this type on self-rectification. Maximum technic 10 M.A., 65 KVP, 100 seconds or 1000 M.A.S.

Right angle tubes are most exclusively used in Dental Radiography and they apply the necessary safety in getting close to the patient's face. These tubes provide an excess of heat storage capacity for such work and function amazingly well in any dental X-ray laboratory. Full mouth exposures may be made repeatedly.

Why Hot Cathode Tubes Are Popular

There are several advantages in favor of Hot Cathode tubes. The electron emission and high potential of the tube may be easily and quite accurately determined by regulating the temperature of the cathode filament. This is done by means of a filament control on the working panel of the machine. The accurate regulation of both the quantity and

the quality of current produces X-rays of better radiographic or spinographic results.

Anode (Positive or Radiator end)

This end consists of a tungsten button, inlaid in a block of a special kind of copper, which allows a rapid dispersement of heat from the focal spot. This makes the tube self-rectifying up to a certain point. This is to say that self-rectification exists until the tube's anode gets too hot or attains a maximum heat storage of 100,000 units of Kilo-Volt-Peak x M.A. x Seconds. A rod, usually of copper, extends from the target outward through the tube's arm to which is fastened the radiator.

Anode of the Universal Type Tube

The Universal type tube differs from the radiator type in that it has a broader focal point and a much higher heat capacity. This permits the delivery of a greater amount of X-ray energy for a short time or a small amount over a long period of time. The heat is practically dispersed and radiated out through the walls of its large glass bulb. These qualities make this type of tube more valuable in industrial work, therapy or X-ray treatment than the radiator type. Instead of its anode being copper, it is usually a solid block of tungsten metal with a molybdeum stem. This metal is used because of its high melting point, thus it can withstand the heat of the terrific bombardment of rays.

The negative is quite similar to the cathode of the radiator tube.

Focal Spot

As X-rays are really directed and not focused, the term "focal point" is rather misleading. Electrons are directed by a suitable cathode so that the greater portion strike a small area on the target known as the focal point line or spot. It is customary to refer to the size of the focal point as a broad, medium, fine, or extra fine focus. This distinction

is very important because of its relation to the sharpness of the image. It also specifies how much power may be used without damage to the target.

Some tubes are constructed with double focus, and two filaments, which give a fine and large focal spot or point. By turning a switch on the cathode end, the tube can be used for fine detail with low current, or less detail with more current. In other words, such a tube will operate from fine to broad focus.

The Cathode

The cathode is the negative end and consists of coils of filament wire usually of tungsten or similar metal. These coils are placed, within a molybdenum cylinder, on a cup-shaped piece and adjusted to direct the electronic or cathode stream to a certain point on the tungsten button of the tube's target.

A special kind of wire metal is used for lead wires through the tube's negative end. Then both ends of the tube and bowl are properly sealed and all gasses eliminated by excessive heat to produce a highly vacuum tube.

Life of an X-ray Tube

The life of an X-ray tube is indefinite. It cannot be predetermined or guaranteed. The failure of tubes to properly function is generally caused by abuse or lack of knowledge in handling or operating them, rather than the ordinary wear and tear of service. Tubes are a delicate piece of mechanism and must be handled very carefully.

Gas in the Tube

Gas may appear within a tube, first, either by overloading it, i.e., attempting to force more current through it than it can accommodate or by too lengthy exposures. Second, it may be due to a small leak in the glass tube itself. Usually such a leak is found at either end of the arms.

When a small amount of gas appears in the tube, it is

often visible as a hue of greenish fluorescence and there will be more or less irregularity in the tube operation.

Often times one can eliminate this amount of gas in the tube by passing through it, repeatedly, small amounts of current—approximately 5 M.A. at 75 KVP — for several minutes. However, when a large amount of gas is formed, it is best to send the tube to the factory for repairs.

Discolored Bulb

Such discoloration is usually due to chemical changes within the tube during the production of X-rays or a deposit of tungsten on the inner wall of the tube. This is either the result of too high a potential, or use of the tube beyond its rated capacity. It does not materially interfere with the quality of work, but it does tend to shorten the life of the tube.

The modern trend in X-ray work, toward the Ray-Proof shield and Shock-Proof equipment, has produced radical changes in X-ray tube design. Consequently new cylindrical glass tubes, approximately 2 inches in diameter, and of various lengths have been built to fill the needs, as the older type bulb was too bulky to enclose in a suitable size shield. However, the four line focal spots are still available.

Though these tubes are more expensive, it is claimed by the manufacturer that they do have a greater operating efficiency.

The Ray-Proof shield tube is air-cooled. Its shield is bakelite, impregnated with lead, equivalent to approximately 1/8″ of sheet lead. The tube is automatically centered so that the X-ray beam is always directed out through the adapter cone. The light from the filament may be used to some advantage in centering the tube over the film.

The oil immersed tube is placed in the Shock-Proof casing. The proper oil level is maintained for the expulsion of air. This type of tube has a higher heat rating because of the extra storage capacity provided by the oil. However, careful attention must be used—particularly in a series of rapid

exposures, not to exceed the 100,000 maximum heat units. To be economical and use less than the maximum will insure safety and result in a longer life for the tube.

The Rotating Anode Tube

In recent years great improvements have been brought about in X-ray tube manufacture, probably the greatest of these achievements being the construction of the rotating anode, which employs the principle of assembling the anode on a rotor which revolves at a high rate of speed thus making possible higher tube ratings with finer focal size, whereby the loading capacity of a tube is greatly increased since the electron stream does not strike continuously throughout the exposure at any one point of the focal point. The tubes are available in two types: oil-immersed and the airflow.

The long life of the rotating element, stabilizes and makes operating reliable because of its high rate of heat dissipation. It is applicable to all types of radiographic work.

With the X-ray tube of standard manufacture using a stationary anode the electron stream is directed against a fixed point known as the focal spot. The ability of the anode to dissipate heat generated by the impact of the electron stream governs the tube rating. Generally speaking when the product of kilovolt peak and miliamperage is high the time factor must of necessity be short. Therefore to produce the desired radiographic effects without sacrificing proper penetration and high milliamperage it then becomes necessary to increase the tube time rating. This is brought about by the use of the rotating anode which by its number of revolutions per minute keeps the focal area cool because a different portion of the focal area is constantly being introduced into the electron path.

By employment of the principle of the rotating anode it is possible to obtain a finer focal spot or line with greater capacity for high loading which is a very desirous combination for roentgenographic work over a scope of various

cases in regards to changes in technic factors. Thus in radiographing mental cases, certain muscular incoordinations or children where it is almost impossible to control patient movement, a high milliamperage with a fractional second time exposure can be utilized to bring out the desired effects with greatly improved definition.

The rotating anode is constructed of a large solid tungsten disc target which is supported on a molybdenum stem on a balanced rotor. This replaces the copper anode and focal spot of tungsten of the stationary anode type of tube, and makes maximum heat dissipation obtainable without overheating the anode structure.

Most rotating anode tubes are constructed with a double-focus cathode utilizing two separately controlled filaments which are supplied by two filament transformers. The angle of the target usually is fifteen degrees from the center of the projected beam. At this angle a 14x17″ film at a 36″ tube distance receives complete coverage. Size of the focal spots on the double focus rotating anode tube is usually 1.0 mm. At the present time manufacturers are experimenting with .5 mm. (or one-half millimeter) focal size for greater detail.

Generally speaking tube characteristics of the rotating anode are the same as the tube of conventional stationary anode type with the exception of the motor to revolve the anode, parts of which are enclosed in the tube and in the tube housing. This motor is a single phase induction type motor which revolves at approximately 3300 RPM on 60 cycle current and at 2800 RPM on 50 cycle current.

With the utilization of the rotating anode principle the amount of heat generated would necessitate a focal spot 7½ x 190 mm. in the stationary anode in the case of the large focal spot while an effective focal spot of 1 mm. square, the head would have to be distributed over an area 4 mm. by approximately 190 mm. This tube is capable of storing 72,000 units of heat with a maximum cooling rate of 25,000 units per minute.

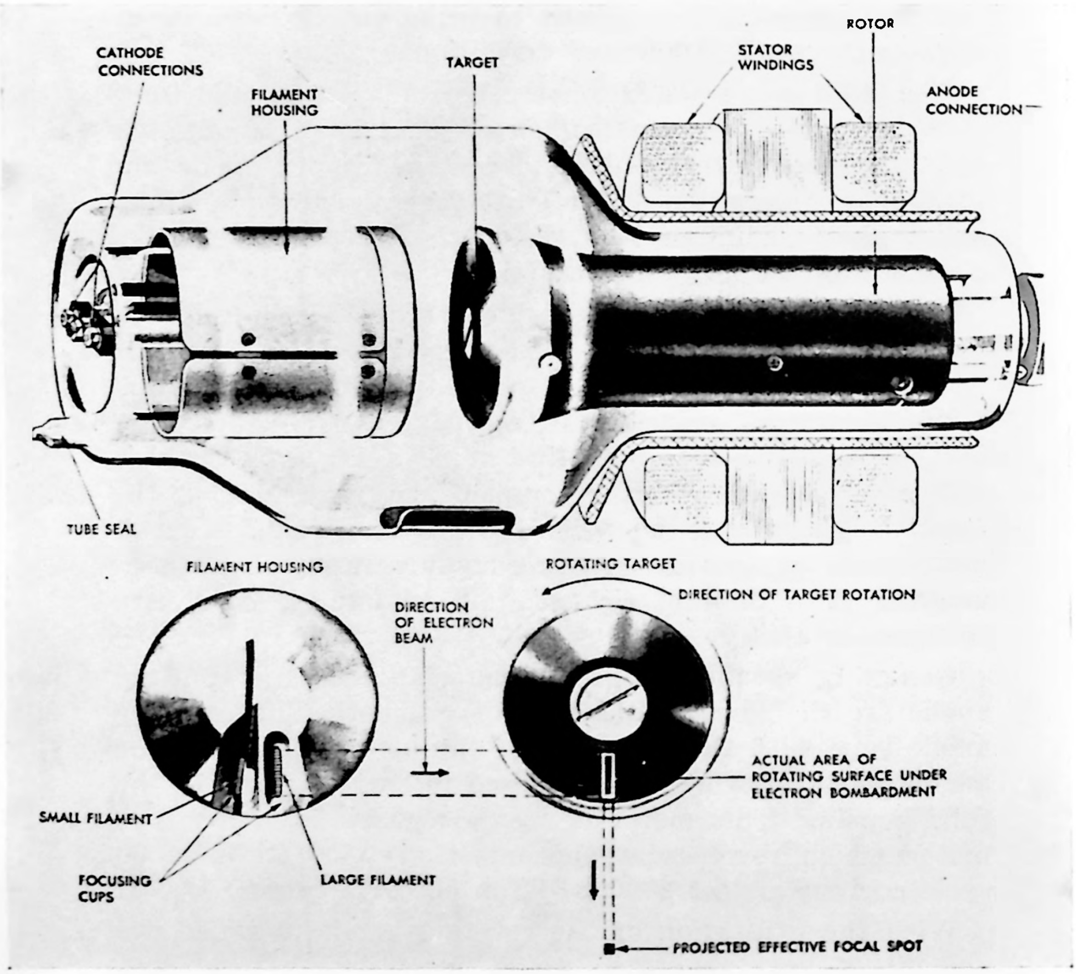


Figure No. 19-A
Rotating Anode Tube

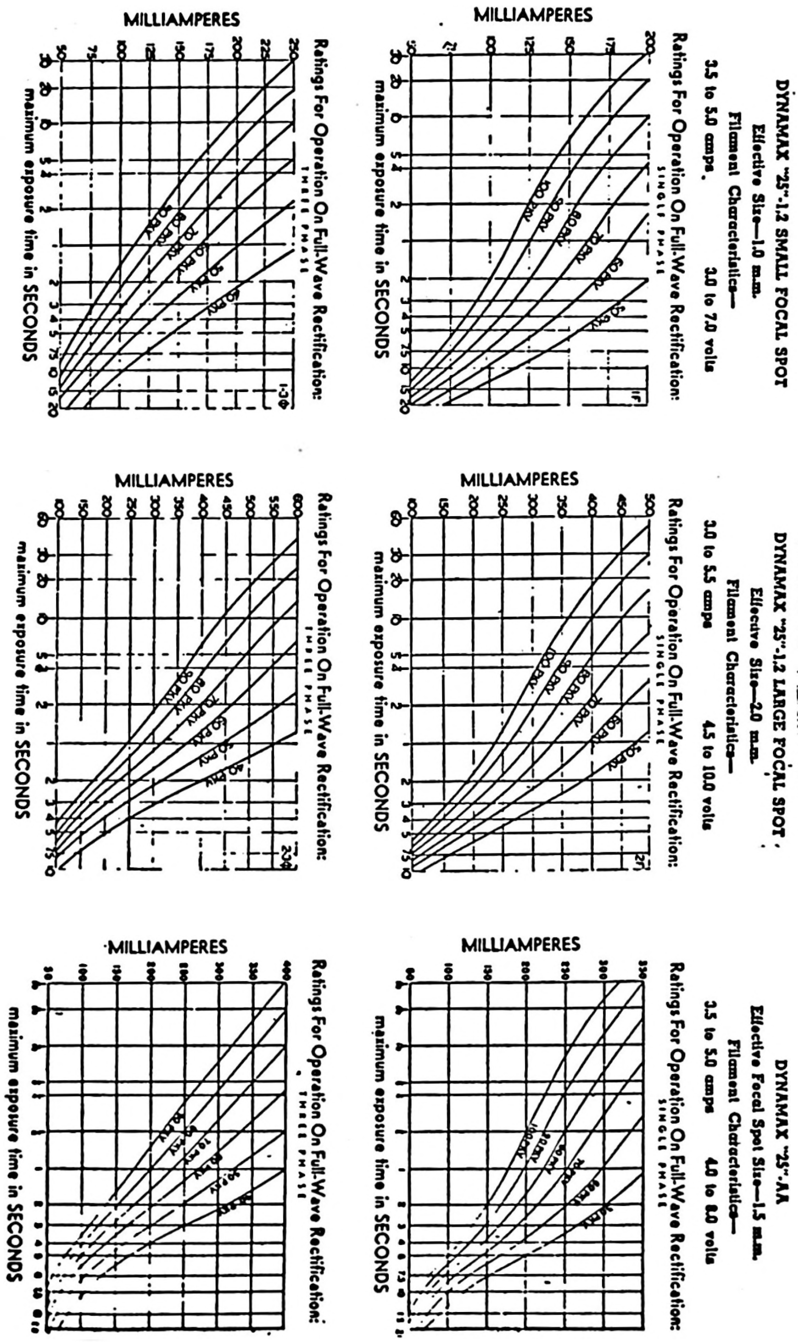


Figure No. 19-B
Rating Chart

The tube housing is constructed of sheet steel with a lead lining, making it rayproof. Of the immersed type, specially processed insulating oil hermetically sealed under vacuum, provides a means of cooling. Expansion chambers adequate to take care of oil expansion through full range of operating temperatures are provided. Of the air-flow type a device to circulate air through the housing similar to a fan is employed and operates on the opposite end of the rotor for an additional means of cooling.

Valve Tube Rectification

As is true of developments in all types of X-ray equipment the means of rectifying high tension current has been greatly improved by the use of valve tubes. These are vacuum tubes having two electrodes, the negative consisting of a heated filament which provides a source of electrons. The positive electrode or anode is a cylinder of metal which surrounds the filament and is kept as cool as possible. The filament when heated permits the passage of the alternating current to the cylinder during one phase; the unheated metal cylinder prevents its passage in the opposite direction during the succeeding phase. Various circuits have been devised utilizing these tubes, rectifying one or both phases of an alternating current.

The great advantage of valve tube rectification over mechanical rectification other than that it being noiseless is that of its greater accuracy and uniformity of the electrical output. Other advantages are that the tubes can be immersed in oil thus saving space and making possible the construction of shockproof X-ray equipment. With the use of only one valve tube we have half wave rectification because one-half of the cycle is suppressed in the valve tube.

One of the most important considerations in the operation of valve tubes is the protection from inverse currents, therefore it is important that specifications of tube capacity and operational conditions be strictly adhered to. If it is designed for operation in oil immersion it cannot be

safely operated in air except at reduced voltages to prevent arcing.

Further consideration must be given the type of circuit employed. Most tubes are designed for full wave rectified circuits; if other than full wave is utilized the load current rating must be corrected to determine the peak value of current passed by each valve tube. To conserve the life of the tube it is important that it be operated at proper filament temperatures and only be turned on just shortly before the exposure is made and then turned off immediately after the completion of the exposure.

The author would like to suggest that if you have not witnessed the construction of X-ray tubes, you should do so. Go visit some standard manufacturer of X-ray tubes and they will kindly invite you in and take you through the plant. It is extremely interesting as well as informative. If you are at all mechanically inclined, as you pass through you will appreciate the type of machinery, the special tools, the raw materials used, and the required amount of experience and education necessary in the building of modern X-ray tubes.

The first point of interest is the vast amount of stock necessary to produce the finished product. You will see glass, cut in various sizes and shapes; molybdenum, silver, copper, and tungsten wire; tubing; bars; screws; etchings; acids; discs; fittings of all kinds; oxygen and hydrogen tanks; electric furnaces; and ovens, as well as numerous other pieces of equipment and materials.

Perhaps the most interesting of all is the electric vacuum furnaces where the tungsten disc and pieces of copper rods are placed in carbon crucibles in the furnace. Then after the furnace top is bolted down and sealed under water pressure the pumps start to exhaust the air. When a certain vacuum is indicated, electric current is switched on. This current melts the copper; seals the tungsten disc and forms it into crude anode terminals. Next these terminals are machined and a proper angle of face is made, then they

are ground and at last are ready for assembly. As they are finished they go to the glass blower to be assembled and sealed in the arm of the tube's shell.

The cathode terminal is assembled and placed in the other arm and very carefully adjusted into its proper position. The assembly and positioning of this part of the tube is a very difficult and important operation, as this determines the character of the focus in the completed tube. It is interesting to know that much of the assembling is done by gloved hands to avoid any contamination of the parts. It is said that cleanliness, involved in these operations, means much in the production of a tube that will operate with perfect stability.

The next step is the aligning of both cathode and anode end for sealing. A great deal of skill and patience is required in this operation in order that the tube will project its beam correctly. While sealing the glass halves, these parts are placed in a type of lathe, which revolves them in perfect synchronism with intense gas flames forced against the shells. This anneals the glass at the point to be sealed until they can be moulded into shape and the tube bulb is completed.

The tube is then placed in an oven and sealed onto pumps for hours of heating and pumping until tests prove by certain gauges that the tube is absolutely free from all gasses.

After a certain process of cooling the tube is given tests for capacity of focal spot, gasses and stability. It is then placed on the shelf for a definite amount of time to check for possible leaks. A final test is then made, the tube is registered, and at last crated for shipment.

At the present time the rotating anode is a much more expensive tube to operate. Not only because of the tube itself but its weight necessitates a heavier and more substantial tube stand with arm. Such a tube stand must operate on ceiling and floor rails. There must be absolutely no vibration in the operation of a rotating anode tube.

CHAPTER 15

EXPOSURE FACTORS
(Calculating Technic)

There is always some difference of opinion as to which type of exposure constitutes the proper spinograph or ideal radiograph but those directly concerned will agree on the necessity and importance of an X-ray film that will reveal the following:

A—Absolute precision placement.

B—Osseous or soft tissue definition.

C—Analytical or diagnostic contrast.

D—The least amount of distortion.

E—Sufficient film density to bring out these qualities.

It must be remembered that X-rays are not fool-proof. Too many are not properly taken or correctly read, either because some part of the technic was incorrect or improper placement was not recognized and not compensated for at the time the spinograph was analyzed. One may be able to describe a bone, an organ or spinal articulation but to be able to recognize these parts on the film seems to be another thing. This means the chiropractor must have some sense of imagination and that before he takes up the study of commercial X-ray he must be well grounded in osteology and anatomy. When I say "well-grounded" I mean just that, for he will then have less difficulty recognizing the descriptive parts on the film.

The chiropractor has rules to follow when taking and reading his films, but he must remember that anomalies and malformations seem to always exist which bring about the exception to the rule. This means there are no two individuals alike, and that all spinal columns are different in some respects. This is particularly true of the upper cervical region. Experience then becomes the important factor. It is the opinion that any X-ray course only establishes a

foundation which the student may build upon through his experience. Like any apprentice he learns to measure and lay out his work. When he becomes a journeyman he should have the rudiments, then he begins to build on his foundation. If his foundation is sound and he has mechanical ability and his experience continues to build he becomes successful. This is true in any line of endeavor.

When these five qualities are realized it will be readily understood that they govern the quality and value of any X-ray film. Though these qualities are essential it is understood they are entirely independent of one another and may be separately controlled and consistently duplicated, so to speak.

Technically, there are five prime factors necessary in the making of any radiograph. They are milliamperes (M.A.) and kilovolt peak (K.V.P.) which are controlled by the X-ray machine. Next is exposure time (M.A.S.) and tube distance, which are controlled by the technician or operator. The fifth is the thickness or density of the region to be exposed. To determine thickness in inches or centimeters is simple.

Exposure time or milliampere second (M.A.S.) is the product of M.A. x exposure time in seconds. For example:

20 M.A. x 10 sec. = 200 M.A.S.
10 M.A. x 20 sec. = 200 M.A.S.
50 M.A. x 4 sec. = 200 M.A.S.
100 M.A. x 2 sec. = 200 M.A.S.
200 M.A. x 1 sec. = 200 M.A.S.

The effects of milliampere seconds on the X-ray film may be compared with the effect of light thru the photographic camera. The amount of light is determined by the size of the opening of the shutter multiplied by the exposure time.

The opacity of the various parts of the body in different individuals varies the density even though the body thickness is the same. For instance: two people that measure 8″ thru the pelvis which is equivalent to approximately 31½

centimeters (centimeter is 1/100th of a meter or 0.3937 inches) do not offer the same body resistance to the X-ray because one individual does heavy work, exercising and developing his muscles while the other sits at a desk. By the same token two people may measure the same but one individual is 30 and the other 60 years of age. At the age of 60 many people lose much of their calcium which means their spinal bones offer less resistance to the X-ray. So as the body density changes, the technic must be changed. Muscular development requires a heavy technic so to speak, and vertebrae having less calcium demand a lesser technic to produce sufficient contrast and the necessary detail. In other words, there can be no set technic or radiographic rule that will suffice for all individuals. Spinographic technic changes with patient's age, thickness of part and some physical conditions, assuming all other factors are equal. Therefore, it is only the intent throughout this text to give you a good film foundation, a starting place or the first step, to take the first or trial picture. From the outcome of this you should have an idea what to do if the second exposure is necessary.

In order for one to consistently produce spinographs or radiographs of desired quality the technician or operator must of necessity possess some amount of skill along with a thorough knowledge of the fundamental principles which tend to vary X-ray technic. To meet these requirements experience is necessary. Naturally the more experience one has along certain lines, the better fitted he is for that particular task.

From various textbooks and equipment manufacturers it is possible to obtain complete technic charts, but at best they can only be used as a guide and because of existing conditions in various localities alteration of such charts usually will have to be undertaken. Certain individual habits, preferences or procedures on the part of the technician or operator will change technic factors from what another technician may desire. Therefore the important thing for

the technician to aim at is desired quality of films by becoming familiar with his equipment, striving to apply the fundamental laws, and observing with a critical eye his results with the thought in mind of constantly trying to improve his work.

An X-ray film of desired quality should possess a proper ratio between fine detail or definition, sufficient density, and ample contrast with a minimum of distortion. The density of any radiograph will depend largely upon the amount of radiation reaching the film. The intensity of radiation varies inversely as the square of the focal film distance. Generally speaking it requires approximately 33 kilovolt peak to penetrate one centimeter of tissue thickness. For every additional centimeter of tissue thickness it then becomes necessary to increase the voltage by approximately 2 kilovolt peak. Another general rule is to double the thickness of part in centimeters and add thirty which in most instances will give one the proper kilovolt peak.

To make a film with a minimum amount of distortion the tube distance should be increased so that the wider angle of angling rays miss the film entirely, but in order to do this the time exposure factor or the amount of current (MA) must be increased. While operating equipment with a comparatively small milliamperage capacity it then becomes necessary to increase the exposure time, within reason of course of the manufacturer's rating of that particular tube being utilized. When tube distance is doubled radiographic intensity is reduced to one fourth, therefore four times as many milliampere seconds will be required to produce the same effect.

The relationship between milliamperage and time is often a variable factor. When spinographing children, mental cases, or persons with uncontrollable muscular incoordination, it is advisable in order to eliminate motion on the film to increase the milliamperage and decrease the time. Milliamperage and time work hand in hand. Because the intensity of radiation is essentially the product of time and milli-

amperage it is commonly known as milliampere seconds. Generally when one increases the milliamperage the time factor is decreased and vice versa. Suppose for example the desired technic called for 200 milliampere seconds. The capacity of the tube being only 50 milliamperes in this instance would then require the operation of that tube for four seconds. Its operation for one second would produce 50 milliampere seconds and only 25 if operated only one-half second.

While there is no proper relationship between kilovolt peak and time still it is possible to compensate for the correct amount of film density. If one is desirous of decreasing exposure time 50% for instance while using double intensifying screens he should increase the kilovolt peak from 10 to 20%. In the same case to increase the exposure time 50% it would be necessary to decrease the kilovolt peak from 10 to 20%. These variations of course are done at the expense of film contrast. A further application of this general rule is that to decrease 10 kilovolt peak, twice the milliampere seconds is required, while a decrease of 15 kilovolt will require four times the milliampere seconds, and 28 kilovolt peak requires ten times the original milliampere seconds. If necessary to increase the kilovolt peak by ten only half the milliampere seconds are required, while a 15 kilovolt peak increase requires only one-fourth as many and 28 kilovolt peak only one-tenth the original amount of milliampere seconds.

With the above laws in mind which underly technic factors it is then possible for one to establish exposure factors to be employed in his own laboratory. Since we already know that approximately 33 kilovolt peak is necessary to penetrate one centimeter of tissue thickness and an increase of two kilovolt peak is necessary for each additional centimeter of tissue thickness, it then becomes a fairly simple matter of measuring and determining the approximate amount of penetration. With tube distance, bucky and screen requirements already determined, the time and milliamper-

age relationship remains the only additional factor necessary. For general purposes as a guide one could use the following milliampere seconds, keeping in mind there are many combinations in the milliampere seconds to employ in the taking of any radiograph. What works for one individual may not work for another. What one individual desires may not satisfy another. For this reason you will find various combinations in technic throughout this text.

Cervical or Dorsal spine	75 to 150
Skull	75 to 150
Pelvis	75 to 150
Lumbar spine	150 to 200
Abdominal viscera	60 to 100
Chest (6 foot)	10 to 20
Extremities (No screens)	100

Depending largely upon the tube rating of the particular tube being employed the time and milliamperage can be established. It must be borne in mind however that the above fundamentals and principles are only general and at best can only serve as a guide on which one can base a technic satisfactory to his own requirements. After these factors have been taken into consideration the trial run method should be employed to obtain the best results. Developing such films, of course, should be done in fresh solutions at the proper time and temperature. By following such a procedure one should eliminate darkroom difficulties and confine changes in improvements to the machine room.

After one has a certain amount of experience he will develop certain short cut methods in arriving at various technics. Oftentimes it will be necessary to sacrifice or change already established exposure factors. With the application of the fundamentals it is possible to change these factors to one's desire or without the loss of the film.

These short-cut methods that technicians often apply are in fracture cases where it is necessary to X-ray through a plaster cast. A simple rule to follow in such cases is to

double the time exposure factor ordinarily used in most cases; if this is not possible an additional 10 kilovolt peak will usually bring about good results. If the cast has just been recently applied and is still wet it is often necessary to increase the kilovolt peak by about 6 or 8 over the ordinary amount of penetration.

In some instances soft tissue of extremities is desired; in such cases simply use half the ordinary exposure time or decrease the penetration value by 8 or 10 points.

Chest films of infants and small children usually require an increase rather than a decrease in penetration. An increase of from three to five kilovolt peak will usually suffice. When films are over-exposed cut the developing time. There is nothing to do to improve the under-exposure except to retake the view.

CHAPTER 16

A DARK ROOM SUMMARY

Equipment

The first place to check for X-ray difficulty is in the Dark Room.

a. Exclude all ordinary light, plug up any cracks in the wall, the key holes, and around the doors. Ventilate the room.

b. Have sufficient developer to completely cover the film —alkaline in nature, of proper strength and temperature (65 to 68°). New solution should be of clear, amber color. Old solution is riley, muddy, and has a strong odor. Have safe light above developer, also dark room timer near at hand.

c. Use clean rinse water. Stagnant water will not rinse developer from the film and would result in hypo deterioration.

d. Use sufficient hypo, caleld "fixing bath"—acid in nature, temperature same as developer (65 to 68° F.). Good quality of hypo is a dark bluish-green color. Worn out hypo is a light blue. Poor hypo causes reddish film stain. Provide ordinary 8x10 reading box above hypo tank for the purpose of examining wet processed films.

e. Tank should be large enough for film washing and must have running water. Insufficient washing causes films to become greasy. Temperature should not exceed 72 degrees.

f. Use drying rack or cabinet with an electric fan for circulation and quick drying of films. Locate drying rack over wash tank so the water will drip from the films into the tank.

g. Room must be clean, free from dust, otherwise films will dry rough with dust and dirt. Using the drying rack properly dried films will be black, smooth and shiny.

h. Loading bench must be clean and as far from solutions as possible, otherwise solution may splatter on films or intensifying screens which causes poor quality films.

i. Rack for empty film hangers, all sizes, located conveniently above the loading bench. Have safe-light near at hand.

j. Have leaded film storage cabinet near loading bench for unexposed films. (The lead should be at least one-sixteenth of an inch thick.)

k. A two compartment, four-door type lead cabinet for storing loaded cassettes is convenient. This type permits the operator to load the cassettes and place in cabinet to be received from outside the darkroom.

l. Have indirect safe light over head in center of room with bright light near it; both switches should be just inside of dark room at left of the door.

Procedure

a. Enter dark room. Turn on switch controlling bright lights. Place exposed cassettes on bench with the cassette covers toward you. At the same time turn on the safe light over the loading bench.

b. Take down correct number of developing hangers necessary and place on bench near cassettes.

c. Remove covers from the top of solution tanks, stir and take temperature.

d. See that darkroom clock is ready for operation.

e. Close darkroom door and lock, unless using a two-way hall or approach for the exclusion of ordinary light. Turn off bright light, turn on the ceiling safelight—located in the center of the room.

f. Walk over to the loading bench. By this time your eyes will have become accustomed to the safelight which is either red or green. Previously, darkrooms have been painted black but authorities now claim a light color is more suitable for more safe light is needed.

g. Begin unloading the cassettes; have the cassette placed flat on the bench in front of you, with the cover up, face down. Press down on the cover springs, usually two in number, raise and open with the left hand. At the same time lift the cassette frame with the right hand—keeping the hinge end on the bench, then tip the cassette left—still maintaining approximately a three-inch separation between the cover and frame, this will allow the film to fall over against the cover. Then thrust the thumb and finger of the right hand between the cover and frame, tip the cassette to the right and allow the film to fall against the finger and thumb. Take hold of the extreme edge of the film, allowing both cover and frame to rest flat on the bench and at the same time raise and extract the film without drawing it across the intensifying screens or the cassette frame. This procedure will add to the elimination of static marks on the film, which are caused by friction.

When loading the cassette, the same is placed on the bench entirely open and screens are brushed with camel hair brush. Then remove film package from the lead cabinet, open and take out one film at a time. Films will be found in between a folded piece of black paper. Holding the film in such a manner as to allow one half of the black paper to fall away from the film, pick up the film at the opposite edge and permit the paper to drop entirely away from the film. Film is then placed in the cassette carefully and the cover closed; make sure that both clips of the cover are properly locked in the cassette frame. Be sure to place the cover back on the film box and return to the lead cabinet. Bear in mind that films are to be handled by their extreme edges only, otherwise finger prints will develop on films.

h. All exposed films should be removed from the cassettes and placed in the developing hangers at one time. Proceed then to the developing tank, start the darkroom timer, or note the time and submerge all films in the developer as near the same time as possible, briskly shaking each film two or three times to prevent air bubbles forming on the negative.

This would otherwise result in blisters on the developed film. Rubberized aprons should always be used to prevent the solution from splattering on one's clothing as the fixing bath, particularly, will eat holes in cloth and spot one's shoes. Be careful to allow solutions to drip in their original tanks. This is particularly true when taking a film out of the hypo and holding the same in front of reading box for examination before the film has been sufficiently fixed.

i. In about a minute and a half to two minutes of development the films are removed, one by one, to be examined in front of the safe light. On the properly exposed film the image will begin to appear in about that minute and a half. If such is the case that particular film will not have to be viewed again for it will develop in five or six minutes, **the proper developing time.** If the image does not appear in that minute and a half you will know that the film was underexposed and will perhaps not develop into a good quality film, assuming now the solution is efficient and of proper temperature. The over-exposed film will appear rather dark in the first minute and a half to two minutes of developing. It should be viewed again during this process, for a full five or six minutes developing would perhaps make the film black and of little analytical value. This particular film should perhaps be removed from the developer with as little development as three minutes.

j. Films are then removed from the developer and rinsed briskly, swished back and forth in the rinse water three or four times to rinse off the developing solution and then placed in the hypo or fixing bath.

k. Here the film remains for fifteen minutes to prevent film fading, although two to three minutes of time in this solution should sufficiently fix to enable one to examine it in front of bright light, with no ill effect on the film. **Replace film in the hypo for a total of fifteen minutes.**

l. During extreme heated periods the chrome alum, the hardening agent in the fixing bath, may not be of sufficient quality to harden the film emulsion, in order to remain in the

wash tank thirty minutes. To overcome this additional hardeners are used. A most satisfactory one is, one part of formaldehyde to sixty parts of water, and it should be used between the fixing bath or hypo and the wash tank. Submerging the film for a few seconds and then removing is sufficient to complete the hardening process. Remember this added solution is only to be used when torrid temperatures prevail, otherwise the film emulsion would become rather soft and possibly sticky.

m. The films are washed thirty minutes in running water of not more than seventy-two degrees temperature.

n. After films are removed, first swish them about in the tank, being careful not to scratch them, then hang the films to dry with a fan near by which circulates the air in the room, or use a cabinet dryer.

o. Dry your hands thoroughly, return to loading bench, open the cassettes and reload them with unexposed films, place cover on the film box, and return box to the lead cabinet; thus the cassettes are placed in their respective place for use.

p. Ordinarily films dry in approximately two hours but the usual procedure is to remove the dried films the following morning — clipping off the corners and replacing the hangers in their respective places. One must be careful not to scratch or mar the films.

q. The films are sorted, placed in their proper envelopes and then read.

In conclusion keep your darkroom clean and tidy and eliminate all unnecessary lights. Keep film developing hangers free from corrosion by the use of acetic acid. A five-gallon container of developer, as well as fixer, if properly cared for (by maintaining proper and constant temperature, keeping it covered to prevent oxidation, and preventing chemicals coming together) will last for some time. It will care for perhaps 400 or 500 negatives.

CHAPTER 17

PLAN OF MODERN DARKROOM AND EQUIPMENT

Proper ventilation should be used in the darkroom by installing an exhaust fan.

1. Place drying rack over wash tank. This rack is usually constructed of wood with sufficient notches to hold the developing hangers in place. Otherwise directing a fan on the films for quick drying might move the hangers and result in scratched or damaged films. Perhaps this method of drying the films is just as good and obviously less expensive. However regular steel cabinets with fan enclosed, known as film dryers, can be had for this purpose. If using the rack and fan method the darkroom must be well ventilated, kept clean, free from dust and dirt, or the films will not dry quickly and the result will be dirty rough films.

2. The wash tank should be large enough for one's needs, connected with cold, running water and have an overflow and drain valve. A lead-lined tank is the best because the solutions have no chemical effect on the lead.

3. An 8 x 10 illuminator or larger should be placed conveniently above the hypo or fixing tank for the purpose of reading wet films, which may not be thoroughly fixed. This is not considered a proper spinographic procedure although it is done. The objection is that one may interpret the wet shadows incorrectly, particularly if it happens to be a border line case.

4. The 10 or 15 gallon hypo or fixing tanks are perhaps the proper size for they eliminate a greater percentage of film scratching. Incidentally, all solution tanks should have covers to prevent oxidation.

5. There are many types of developing tanks on the market. The best has a thermostatic control which keeps the solution at a temperature—ranging from 65 to 68°. There is a size and design of tank to meet all requirements.

Another tank, costing less and answering the purpose, is a sufficiently lead-lined wooden box with partitions to receive the regular five, ten, or fifteen gallon tank inserts as the case may be. A small separate rinse tank, lead lined, should be placed between the two solutions. It should connect with the cold running water.

With this setup, it is possible to employ the use of coils around the inside of the large wooden lead-lined tank to be connected with an electric ice-box unit. It can be automatically controlled, and with hot and cold water available in the darkroom, this unit will keep the temperature correct. The proper temperature not only produces a better quality film but tends to lengthen the life of the solution.

6. Developing tanks are made in the same sizes as the hypo tanks.

7. The safe light, preferably 8 x 10″ size with red or green shade, should be conveniently placed above the developing tank so that the solution from the films will drip back into the tank. This is a very important darkroom fixture, for a light which is not safe will fog and perhaps ruin the films.

8. Have a switch controlling the safe light or illuminator over the solution tanks.

9. Place a shelf over the solution tank for the storage of mixed solution.

10. Employs two or four door lead-lined cabinet for placing the loaded cassettes for use. The four door is the better type, two doors opening into the operating room—the other two into the darkroom so that the cassettes may be received from either room. All unexposed films must be stored in a lead-lined cabinet otherwise they will become fogged with secondary radiation. For complete safety, it is advisable to line the wall between the darkroom and machine room with 1-16″ virgin sheet lead.

11. and 12. Sink with hot and cold water necessary, also same to be supplied to large processing tank.

13. Use indirect ceiling safe light, red or green shade. All safe lights should have the same colored shades.

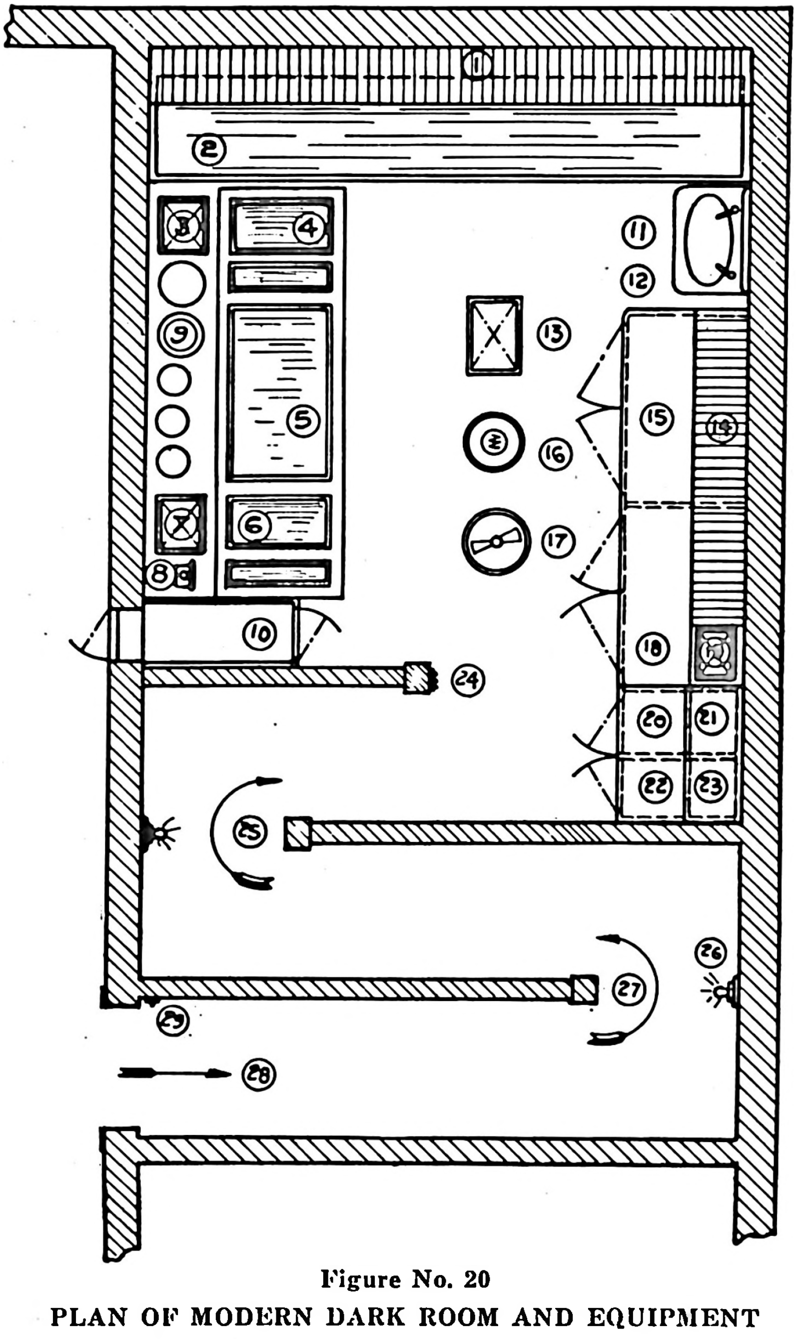


Figure No. 20

PLAN OF MODERN DARK ROOM AND EQUIPMENT

14. Have wooden rack notched for the suspension of developing hangers of all sizes, conveniently located above the loading bench.

15. and 18. Provide for loading bench with cupboards underneath. This bench must be as far as possible from the solution tanks.

16. Ordinary ceiling light.

17. Electric fan.

19. Small safe light conveniently located over the loading bench.

20 to 23 inclusive. Lead lined storage cabinet for unexposed films including dental films.

24. Switch for ceiling and indirect light.

25. 27. and 28. Open entrance with properly arranged partitions to exclude all ordinary light.

26. Red colored ball lights.

29. Switch for colored lights.

CHAPTER 18

MODERN DARKROOM CONSTRUCTION, DESCRIPTION AND PROCEDURES

The darkroom is the heart or the hub of your X-ray laboratory, therefore too much stress cannot be laid on the importance of its construction, proper equipment, and technical procedure, whether it be for the average spinographer in private practice or for one who conducts a general X-ray laboratory. Its very significance is the most important phase of the X-ray work. As it is obvious that results depend entirely on the facilities and procedure used, equip it in a modern and scientific manner. The results will be evident in the speed, convenience, and quality of the work accomplished. Films may be saved or may be ruined in the darkroom, for spinography or radiography begins there and ends there. Thus naturally, it behooves one to check these procedures and keep continually trying to improve one's work in this manner.

Directions and suggestions offered here are based on many years of experience and observation, and if followed closely consistent results will be obtained. An adequate darkroom, proper handling of the developing hangers and films, and the loading and unloading of the cassettes preparatory to developing and fixing are just as important, and perhaps more so, than the actual placing of the patient, the exposure time, and the centering of the X-ray tube.

Manufacturers are constantly devoting time and money to the study of darkroom procedures because they are so important. Through their constant research, new and improved devices are being developed to help the technician in the production of better X-ray pictures and to lighten his daily routine.

Description

The location of the darkroom and its size are first to be considered. It should be within a reasonable distance of the

X-ray machine, and to avoid confusion, it must be of sufficient size to work in conveniently. Plumbing and electrical connections are necessary but ventilation is also a most important factor. Very often darkrooms are made in small closets or lavatories, and in some instances they are found in basements. Good results cannot be obtained in this manner, for confusion, little or no ventilation, dampness and other objectionable features make for poor end results. The construction of the darkroom must be of such material as to preclude leakage of ordinary light and X-rays. If this leakage presents a problem, the wall adjacent or facing the operating room should be lined with 1-16″ lead, for lead absorbs the X-rays. Incidentally, a lead-lined box, conveniently placed in the darkroom, is also necessary for the keeping of exposed films.

The size of the darkroom is determined by the nature and the average amount of work to be done. Its minimum dimensions should still allow room for convenient and efficient procedure. The room must be kept clean, free from dirt and dust, so that when an electric fan is used to dry the films, they will dry smooth and clean. Otherwise, such films would dry rough and dirty. Too much care cannot be exercised in this respect.

There seems to be a great deal of misunderstanding relative to a darkroom paint color. Heretofore most X-ray laboratories used a jet black or some other dark pigment. This is not necessary for many theories concerning darkroom wall colors have been superseded by a more practical consideration, because of the type of filtration in the modern safe lights. With a lighter hue there is not only an increase in the amount of reflected safe light and a safe visibility, but it will also eliminate wandering about in the darkroom.

Accessory equipment necessary in the darkroom is as follows: safe lights, storage shelves, lead-lined cabinet, loading bench, developing hangers, hanger racks, solution tanks, rinsing and washing tanks, darkroom timer, solution thermometer, drying equipment, electric fan, brown gallon bot-

tles for keeping extra solution, two wooden paddles, sink, camel hair brush for brushing screens and cassettes daily, apron, preferably rubber lined, and other miscellaneous articles.

Illuminators, or safe lights as they are commonly called, cause a large percentage of darkroom trouble. Fogging of the X-ray film is a phenomenon which in many instances is difficult to trace, that is, to determine whether it is caused by the safe light, secondary rays, ordinary light, or chemical reaction. Actually safe lights are not safe in the strictest sense of the word as all safe lights will fog films by excessive exposure. So the problem of film exposure to light is an important one. And in the final analysis, the maximum amount of safe light intensity that may be used, is determined by the following factors:

1. Safe light film distance.
2. Safe light filtration.
3. Speed of operation.

Factors one and three are external variables which may or may not be eliminated—due to the speed of operation. Naturally the remedy is to proceed with the developing procedure as quickly as possible, then either to increase the safe light film distance, or reduce the safe light intensity or both, until this type of fog is entirely eliminated. When red or green safe lights are not safe at a given distance, they may be made safe by one of two things; either replace bulb with one of less wattage or add to the density of the safe light glass by interposing a piece of unexposed film and red or green paper between the glass and the safe light bulb. The size of the electric bulb in the ordinary safe light is 15 to 40 watts.

As safe lights are not always safe, it becomes necessary, when using a highly sensitive film, to test it before attempting to proceed with the developing procedure. Place a metal object on a piece of unexposed X-ray film and hold same in front of the safe light, at a distance of four or five inches. Hold for about one minute. Develop the film and if

the object appears on the film, the light is not safe. This method will also assure one as to the lights that are safe.

The above procedure should be the second check made in your darkroom; the first of course, should be to check for the leakage of ordinary light through cracks in the wall, underneath doors or even through key holes. Either red or green safe lights may be used; one over the loading bench and one over the developing tank.

One can easily clutter up his darkroom by having too much shelf space, much of which usually becomes a catch-all. However, some shelves are necessary for holding extra mixed solution in dark bottles, a pitcher, glass funnel and possibly an illuminator. The most convenient and suitable place for such a shelf is over the developing and fixing solution tanks.

A lead-lined wooden cabinet for the storage and safe keeping of the unexposed films should always be added to one's darkroom accessory list. It is a most important factor for it tends to keep the films from ordinary light exposure and will positively absorb any secondary or static radiation, which is so detrimental to the unexposed film. This storage space should be located over or near the loading bench. Much precaution should be carried out in the machine room and this cabinet, which also has an exposed compartment, will eliminate double exposing.

The loading bench should be large enough to allow for the opening of any sized film package as well as for the loading and unloading of any size cassette. If not large enough some film packages or even the cassettes may fall to the floor and be ruined. The loading bench should be located as far from the solution tanks as possible. It must be kept clean, as any form of contamination may not only ruin the films to a point where diagnostic and analytical qualities are reduced, but it may also damage the intensifying screens.

Racks for modern film developing hangers should be built over the loading bench. Almost any material of sufficient size and strength may be used, but wood is perhaps the most

commonly used because of its decorativeness. Each rack should allow its hangers to hang parallel to each other. Its grooves must be of sufficient depth to prevent the hangers from dropping down on the bench. Film hangers are important in the darkroom. Their purpose is to keep the films suspended during the development. They must be kept clean and free from corrosion as dirty and corroded film hangers will result in films that have numerous finger spots or prints. Also, the corrosion eventually causes an annealment of the spring clips and this prevents the hangers from keeping the film in a taut or flat position. Then should the film bulge or a corner of the film become unclipped during the development, developing is very difficult. This may not ruin the film to a point where it will interfere with listing, but it will give the film a very poor appearance. Acetic acid solution may be used to remove such corrosion.

Tanks for developing, rinsing and fixing should be of sufficient capacity to meet any situation. A cover should be supplied for each tank to prevent light and air oxidation, which might deteriorate the developer. Such tanks should be capable of maintaining correct temperatures with maximum reaction to chemicals.

Perhaps the most desirable and inexpensive tank equipment, is the type operated by a compressor with sufficient refrigerant. This will automatically keep the temperature of the solution between 65 and 68° Fahrenheit. This range of temperature is necessary to proceed with proper development, otherwise films may develop foggy or even too light. This compressor arrangement is accomplished as follows: have copper coils submerged in a proper sized lead tank of water; connect the coils to the compressor, which is operated and controlled by the electric current, with a supply of warm hydrant water to this large lead lined tank; then permanently place solution tank inserts therein and correct temperatures will always be maintained. Such a procedure will add life and strength to the solution.

Films must be thoroughly rinsed between solutions. Im-

mediately following the developing process, the film should be carefully rinsed in clear, running water of proper temperature by rapidly raising and lowering the hanger in the water for about 10 to 15 seconds. Too much time should not be used during this process as the film may continue to develop until placed in the hypo or fixing bath. If this should happen, a chemical fog may be produced by overdeveloping. In reality, the reason for rinsing the film is to prevent too rapid hypo deterioration. A rinse tank such as described above should be drained and cleaned frequently, or the deposits of silver and developer from the developed films will prevent a thorough rinsing.

When the films are developed and fixation is complete the films should wash about thirty minutes in running water. The temperature of the water should not exceed 72° Fahrenheit and must be free from grit, grease or dirt of any description as it is very difficult to remove any of these once attached to the film surface. When washing these films be sure that the water covers the hangers as well. Films not properly washed will dry greasy and very often stained Many times this causes the film to crack, and although it may not materially interfere when reading the film, it again gives it a very poor appearance.

A practical method for keeping the films suspended during this process is a wooden frame made to fit the inside and top of the wash tank. As this frame has grooves cut to fit the bar of the hanger, the films will hang completely submerged and safely parallel to one another—yet far enough apart for washing.

Following the washing process the films should be hung up to dry in a place, free from dust and dirt, with plenty of air circulating around them. The time for completely drying, depends upon sufficient washing, the atmospheric conditions, humidity and temperature of darkroom. A suitable rack for drying, similar to that used for washing can be permanently fastened to the wall and extended out and over the wash tank. This will allow the water to drain off the films and into the wash tank, rather than on the floor.

It is always advisable to maintain the proper temperature rather than add ice directly as this may produce excessive dilution. Avoid excessive heat in drying cabinet or dark room proper or the film emulsion may run. If one changes the fixing bath frequently, during excessive heat periods, it will further insure the proper hardening of the emulsion. Sometimes the use of a cellulose sponge, to remove excessive moisture on the film, will aid in reducing the drying time, and thereby lessen the danger of emulsion run. Such sponges may be purchased from most of the X-ray accessory film companies. If the X-ray film has been processed under normal conditions, a gentle swabbing with this soft durable sponge will not damage the film.

HOT DARKROOM AND HOT SOLUTIONS only add to the many darkroom variables which must be eliminated. Such precautions are bound to produce a better quality of film.

The darkroom timer is a very important accessory, as it will add accuracy to the developing procedure. It should have a luminous dial with large figures; should be sturdy and accurate, and should be of the interval type—to signal when the interval is concluded.

Exposures should be made so that films will develop a full five or six minutes since the last minute of development in a suitable developer adds contrast to the X-ray films.

Perhaps the most inexpensive and convenient way of drying films is to circulate air around them by means of one or two electric fans. Ordinarily this method will dry films in less than one hour. Do not hang wet films above those that are already drying as the water dripping down on such films will spot them.

An accurate thermometer properly calibrated, should be used when testing the solution. It is not advisable to use the type housed in wood, as the wood will absorb the solution and in testing from one tank to the other will eventually cause some contamination and deterioration.

Ventilation is very necessary to one continually working

in the darkroom. It can be increased by using one electric fan to circulate the air and another to draw the air out of the room. This necessitates that a grill of some sort be placed in opposite sides of the room, to receive and discharge the air.

Never attempt to proceed with the developing process immediately following the mixing of solutions as the chemical dust in the room will fog films and the temperature of the solution will be too warm. Even the second condition will produce a fog. If one frees the room of chemical dust and waits for proper solution temperatures this type of fog will be eliminated.

To add new solution to either the worn out developer or to hypo will not increase the efficiency of the worn out or deteriorated solution, for the new solution will be wasted. However, to merely add enough to the tank to completely cover the film, during the developing process, is a common occurrence. Keep the film entirely submerged while developing, for films, not entirely covered, will develop with a light blank strip across the entire film. So always have a quantity of mixed solution on hand. Keep this solution in dark gallon bottles, thoroughly corked to prevent oxidation which is excited by light and air.

One should have two large wooden paddles for mixing and stirring the developer and hypo as the use of one paddle for either solution will cause contamination and deterioration—particularly of the developer for it is the most sensitive of the two.

As these chemicals and solutions will ruin wearing apparel, one should wear an apron, preferably rubber lined, while working in the darkroom. If the solution splatters on your clothing unremovable spots will appear, and many times these spots eat entirely through the clothing.

Procedure

Loading and unloading the cassettes and the handling of unexposed films and film packages are definite procedures

which must be observed to avoid desensitized areas on the film. Careless handling may produce finger prints, crescent marks, static lines and even light fog may be the result. With bright lights off, the safe light on over the loading bench, one may proceed to open the film package which has been taken out of the lead-lined cabinet and placed on the work bench in the darkroom. Remove the cover of this package and note that each film is individually placed between black paper, closed at one end. The entire amount of films in this package are found placed between two separate pieces of cardboard about the size of the films. They are then wrapped in black, then red waxed paper, and a piece of corrugated paper. From this point there are many ways to proceed. Perhaps the best way is to take out the corrugated paper, which will give the films more storage space in the box. It is not advisable to remove the waxed or black wrapping paper with the corrugated paper for they may eventually prevent light fog. As films needed are removed from the box, the wrapping paper should be folded back in its original position, cover replaced and the package returned to the lead-lined cabinet. Incidentally, always store films in upright position.

The modern film holder is of metal, known as the cassette, either bakelite or aluminum faced. It is not uncommon to find some technicians still using the old type cardboard holder which usually is lead-backed. If using the latter type allow the film to remain in the black paper and then place in the holder. When using the modern holder, the film is carefully removed from between the black paper and then placed in the cassette.

To minimize the possibility of abrasion marks, transparent spots, etc., have the necessary cassettes open, brushed out and lined up on the loading bench. Switch the bright light off, the safe lights on; remove film from box, then from black paper, being careful not to drag the film from between this paper or to slide film into the cassette. Instead place the end of film against the inside end of cassette, and

thus allow film to gradually fall in place, remembering to always handle films by their extreme edges. A safe way to remove the film from the black paper is to take the film and paper in your right hand and with your left, lift one edge of this paper; then fold it back and drop it, until it falls entirely away from the film, except for that point as contacted by your right hand. Now raise the opposite end of the film with your left hand, release your right hand, and allow the paper to drop to the floor, away from the film. Should you prefer to begin with your left hand rather than your right, you may do so, however, during this process remember to avoid any possible kinking of films.

Having tested the solution and found the temperature to be about 66 to 68° Fahrenheit, you are now ready to proceed with the developing and fixing process. Let me repeat, place all the cassettes to be unloaded conveniently on the work bench; remove the correct number of hangers from the rack and place likewise. As everything is now in readiness, latch the darkroom door and turn off bright light, then allow two or three minutes of total darkness before lighting the safe lights which should be over the loading bench and developing tank. With your hands clean, dry and free from perspiration, unlock the cover of the cassette; draw the cover back with the left hand, raise and tip the cassette frame with the right until the film falls back against the thumb and finger, and allow the cassette frame to then rest on the bench. Next grasp the film by its very edge and lift it out of the cassette carefully and while closing its cover with the left hand, hold the film with the right hand, then pick up the hanger with the left and engage the film, making certain that your fingers only contact the film by its very edges and that the film is securely fastened in the hanger. Place the films and hanger in a more or less vertical position on the bench. Repeat this procedure, in the above manner, until all films to be developed are in the hangers, always noting the exact time. The films and hangers are then carefully placed one by one in the developing tank; submerge them as quickly as possible and shake

vigorously to prevent air bubbles from forming on the negative.

Before continuing, it would be well to have a resume of what actually takes place in these chemicals, when the film is processed in solution at par strength, and according to prescribed time and temperature. When the X-ray film is exposed to the X-ray a chemical transformation takes place; this causes a re-arrangement of the silver salts in the film emulsion. Theoretically, the stream, as well as the screen's fluorescence, bombards and shatters these silver crystals and the force of this explosion naturally injures the surrounding crystals. The number and depth of the crystals broken in this path of destruction, depends on the angle of the impact and the amount of tissue resistance offered to the X-ray. The exact nature of this chemical change is not definitely known, although it is apparent that a reduction of the silver salts to something metallic is started by the X-ray exposure. However, a complete reduction is necessary and this is brought about and completed chemically by the developer, alkaline, and the fixing bath or hypo, the acid. These chemicals which have the power to reduce the silver salts to a metallic silver must have other characteristics as well. They must react with other agents to produce and control the different steps or graduations between white and black or soft and contrasting tones. Chemicals hydrochinone and metol are reducing agents with excessive speed. Potassium bromide is used as a retarder for the hydrochinone sodium sulphate plays no important part in the actual developing process, other than merely as a preservative. Without this ingredient the reducers would oxidize and their usefulness would rapidly deteriorate. Sodium carbonate paves the way, as it swells the gelatine in which the silver salts are suspended, so that the reducing agents may act without loss of time. Therefore, it controls the speed of the developer.

Three factors control the life of the developer: temperature, age (oxidation and deterioration), and the number of films which have been developed. Some technicians contend that certain exposure or certain ages of developer re-

quire certain specific developing time at a given temperature, but, no doubt, better results are obtained by a full five or six minute development at par strength and temperature. It is the last minute of processing in good developer that adds contrast to any X-ray film.

To further increase results, it is advisable to purchase developer, fixer, and X-ray films from the same manufacturer.

The hypo or fixing solution is the last step in completing the developing process. This solution performs two duties: first, it rids the emulsion of all unexposed or reduced silver salts; second, it preserves or treats the emulsion and prevents any deterioration.

There are five agents that make up the hypo. Hypo sulphite crystals dissolve the unreduced silver salts. At full strength its action is very rapid. Alum is the hardener, which treats and preserves the emulsion. Sulphuric acid counteracts the alkali and immediately stops any further development of the film in the hypo. Sodium sulphite is the preservative. Chrome alum makes the solution opaque to ordinary light, so that the bright light may be turned on, almost immediately after having placed the films in the fixing solution, without danger of fogging the films. However, films must remain in the hypo or fixing solution for a total of fifteen minutes to thoroughly fix and prevent fading.

With the films in the developer proceed as follows: when developing by color lift them out, one by one, and after about two minutes of processing hold in front of the safe light, about four inches away, note the progress, and then place back in the solution. The image on the properly exposed film will begin to appear in about one and one-half to two minutes of developing. Though under-exposure will hardly appear in that time, the over-exposure may be black. Thus it is necessary to look at the films being developed at least once and maybe twice, during this process. But taking them out too many times will slow up the developing process and, too, it may increase the possibility of fogging them. After the film is finished in the developer, it is then rinsed quite vigorously in clean rinsing water and then placed in the hypo

for completion. After fixation the film is placed in running water to wash for 30 minutes and then hung up to dry.

Realizing the importance of the darkroom procedure, it will be pertinent here to add a few darkroom hints which will tend to step up the quality of your work.

Ordinary light fog produces black streaks on the developed film. It may be around the edges or it may be seen across the film. This type of fog may be produced by light rays leaking into the room or by not having the film package or box tightly covered, or by a leakage of the cassette itself. Sometimes it is necessary to reline the cassette with felt, to keep the cassette light proof during the exposure.

Static lines are usually produced on the undeveloped film either by drawing the film over an object or by pulling the film from between the black paper. On the developed film these lines appear very fine and black, sometimes in a sort of fine network of lines. Such discharges may take the form of dots or specks and smudges rather than the delicate lightening-like lines frequently encountered. However, friction in the handling is most always the cause of these markings. Therefore, deliberate film handling is most desirable and an observance of the following precautions is not only helpful but gratifying.

1. Remove film slowly from the package.
2. Let the inter-leaving paper fall away from the film.
3. Place the film in the cassette without sliding it on the screens.
4. Avoid pressure on the films.
5. Do not stack the films in piles before putting on the hangers.
6. Avoid stroking edges of films while fastening in the hangers.
7. Only handle films by the extreme edges.
8. Be sure the film is entirely within the cassette before closing the cassette.

Practically all difficulties can be eliminated by carefully adhering to the above rules.

Yellow stains or a complete yellow tinge on a spinograph film is due to an exhausted fixing solution. When the film is not sufficiently rinsed after development, it will carry some of the developing solution over into the fixing bath, neutralizing it, then the chemical reaction causes these yellow stains. The only remedy is to mix new fixing bath, and then properly rinse films before fixing.

It is claimed by some of the chemical companies that exhausted, yet not completely deteriorated fixer may be restored to a fairly good solution by adding 20% solution of sulphuric acid. The amount of acid to be added may be determined by first noting the color stain of a good fixer on a blotter, then adding enough sulphuric acid to the fixer to bring back the approximate tinge of the exhausted solution.

To improve the keeping qualities of the unexposed negatives it is advisable to store them in a cool place and in a lead-lined cabinet, as secondary radiation from the X-ray room or even static will fog them.

The exposed negatives may be submerged in a 10% solution of alum for a few minutes which will keep them clear and clean, and preserve them permanently. This operation takes place after the film has been properly fixed. Of course, it is necessary to wash the films after taking them out of the alum bath.

Those who operate in an intense heat area will encounter difficulty in storing and keeping the unexposed films. Even to keep the solutions at proper temperatures is usually difficult in such a climate. In cases when provision was not made for this difficulty, films have been found even in the package with their emulsion actually slipping from the base. Therefore, unexposed films must be kept in a cool place. For remember, films with tacky emulsion which have been placed in a cassette for exposure will completely ruin intensifying screens.

If the unexposed films are kept in a cool place, developing may then proceed with little or no difficulty so far as softening of the emulsion on the film is concerned. But to assure

absolute safety, place the films in a solution of sixty parts of water and one part of formaldehyde for a few seconds after development and fixation. This will harden and set the emulsion to the base so that sufficient washing of the film may be made possible. The alum bath, if used, should follow the formaldehyde.

For quick drying of films after development and fixation, they should be thoroughly washed in running water for at least thirty minutes; temperature of water should not exceed 72° Fahrenheit. Then the films should be removed from wash tank and placed in front of an electric fan. The room should not only be well ventilated, but free from dust and dirt. A properly washed and fixed film should dry smooth, black and shiny.

High-speed, intensifying screens are generally used in spinographic and radiographic work. Films exposed with intensifying screens are only as good as the screens permit them to be. Perhaps some increase in detail can be obtained with a medium speed screen but there is a greater possibility of getting motion on the film with this sort of technic, and motion appearing on the film makes the film of no value. Great care should be given these screens in order that they may be made to last and give the best results. Dust and dirt should never be permitted to accumulate on the screen surface. The use of a camel hair brush is advisable in brushing the screens. Evidence of dust and dirt will appear, on the developed film, in minute white spots. It is also true that a laggy, worn out screen, or sometimes screens having excessive crystals in their emulsion, will reveal similar spots on the developed film.

It is always advisable to load and unload the cassettes in the darkroom as far as possible from the chemical solutions, although wet solution spots on the screen's surface can be readily removed with peroxide. But when such solution spots dry on the screen there is nothing that will remove them without damaging the screen's emulsion. Modern screens are washable, this should be done often enough to

keep them clean. To wash, dampen a piece of cotton, then use a little Ivory soap, and rub the screen very lightly. Be sure to remove all the soap from the screen before drying. When drying these screens, a tuft of cotton may again be used and the screens placed in the sunlight; the sun will not only dry but bleach the screens. Be certain that the screens are thoroughly dried before using.

Developer of certain chemical consistency, not oxidized by contact with air or exhausted by continuous usage, requires a certain duration of time to reduce properly the silver bromide salts to a metallic silver deposit on the film emulsion. This is necessary to form the image. Reduction of development should be completed in 5 minutes.

The last minute, so to speak, of this process will add contrast to the negative. If films develop too black, it proves an over-exposure; if too light an under-exposure. To remedy this—decrease your penetration or exposure time, or vice versa, in order that the films will develop in the required five to six minutes of time.

Solutions that have lost their strength will often produce stains. These may obscure details sufficiently to confuse interpretation. Before using solutions stir them well with a wooden paddle and then take the temperature, which should range between 65 and 68° Fahrenheit. If an extra quantity of solution is mixed, keep it in dark corked bottles. This will prevent the light and air from oxidizing the solution. It is not advisable to add new solution to old, except when it is necessary to bring up the level of the solution so that it will cover the films.

CHAPTER 19

PROTECTION AS APPLIED TO ROUTINE WORK IN THE LABORATORY

In this chapter, remarks pertaining to protection directly refer to radiographic procedures and have not so much relation to X-ray treatment work. However there may be some points that will be of value, at least in work of the latter. This discussion, as to safety methods in X-ray procedure, may be regarded as practical rather than scientific.

After many years of experience in the teaching of X-ray work, the writer realizes that information relative to protection must be constantly given and stressed for the benefit of all concerned. It should be understood that he is only expressing his personal opinions, based upon years of practice, in the operation of X-ray machine equipment.

This chapter has been prepared especially for the benefit of students studying X-ray work, particularly those entering this field of endeavor.

The very first consideration is the rule of safety from a moral and legal point of view. It has much to do with the success of any X-ray laboratory, as a matter of fact, in business of any sort.

Next is the type of equipment, referring now to the Shock Proof and Non-Shock Proof Units. If the Non-Shock Proof machine is being used, be sure all wiring is well out of reach. The tube should be enclosed in a lead glass bowl and all equipment grounded to prevent the presence of static electricity. Though static discharges are not dangerous within themselves, they do frighten the patient. This causes patient to move during the exposure.

The next consideration is ability of the operator to do this type of work. Though it has been said that the theory of X-ray remains as its discoverer found it, the methods of procedure keep constantly changing as the result of scientific research and experimentation. Thus to do this work

correctly, with all safety and caution, one must certainly keep abreast of the times.

It is advisable to line the X-ray room with 1-16″ virgin sheet lead, at least the wall adjacent to the office, the reception room, the darkroom and the ceiling, if there are offices or dwellings on the next floor above. X-ray radiation unless absorbed travels a great distance and eventually results in more or less damage.

The maximum amount of rays which any one individual may receive without ill-effect is difficult, if not impossible to determine, for it is generally understood that the milliampere second limit rule is only an average one.

Always employ the use of proper filters. If the 1 mm. aluminum filter is not used, it is said the milliampere second limit should be lessened 1/3. However, the aluminum filter should always be in practice to absorb the soft rays which are so injurious to the health of the patient. It is this type of radiation that, if not absorbed, sometimes results in the "burning of the patient" or perhaps just the erythema dose or Roentgen dermatitis. First Aid: Zinc Oxide, though often the Butesin Pictate or Protomeclein Salve is advised when such conditions appear.

Some individuals are more susceptible to X-ray radiation than others, then too, some may be more susceptible at one time than at another, so the safe procedure is to make inquiry of the patient as to his recent exposures.

Proper preparation and placement of the patient is necessary to avoid retakes. Proper ventilation, sufficient clean white gowns, and cleanliness of the operator are always essential in any X-ray laboratory.

It is always advisable to keep a record of the case from a standpoint of legality and technic. Developing the films immediately after exposures are made eliminates any embarrassment in case the patient need return for retakes.

Proper equipment, complete accessories and minimum working time saves films, decreases danger and helps to eliminate motion. This promotes a friendly feeling between

the operator and patient and naturally produces a better quality film. Protection now will be considered from the standpoint of: 1. the technician
2. the patient
3. the visitor

Protection of the Operator

During the early days of research and experimentation in the production of X-rays, nothing was known of the danger and effect this radiation had on tissues of the body. Thus many X-ray operators were severely burned because of direct contact with the X-rays. Some were injured to the extent of losing their hands, arm and even losing their lives. The same was somewhat true in regard to patients. Obviously, all this was largely the result of improper protection. Today such casualties in radiographic work rarely happen.

Since the operator or technician is operating the equipment from day to day, month by month, he is subject to a greater danger than the patients themselves. Naturally he should provide for himself all the methods of modern protection.

No doubt his greatest danger is the absorption of the secondary radiation. This often causes a general run-down condition, resulting perhaps in anemia, a lack of quality or quantity of blood and it is also said to produce sterility. Some authorities claim that the reproductive germ in time may appear fertile while others are of the opinion it will not.

Because of this radiation the operator should protect himself by operating from behind a lead-lined screen or preferably either in a lead-lined booth or in a lead-lined room. The latter is used when operating a remote control unit. For this type, the control panel is enclosed in such a room. Observation of the patient and equipment is made through leaded-glass windows.

Secondary rays, though traveling in straight lines strike and explode or are absorbed. These rays usually travel in

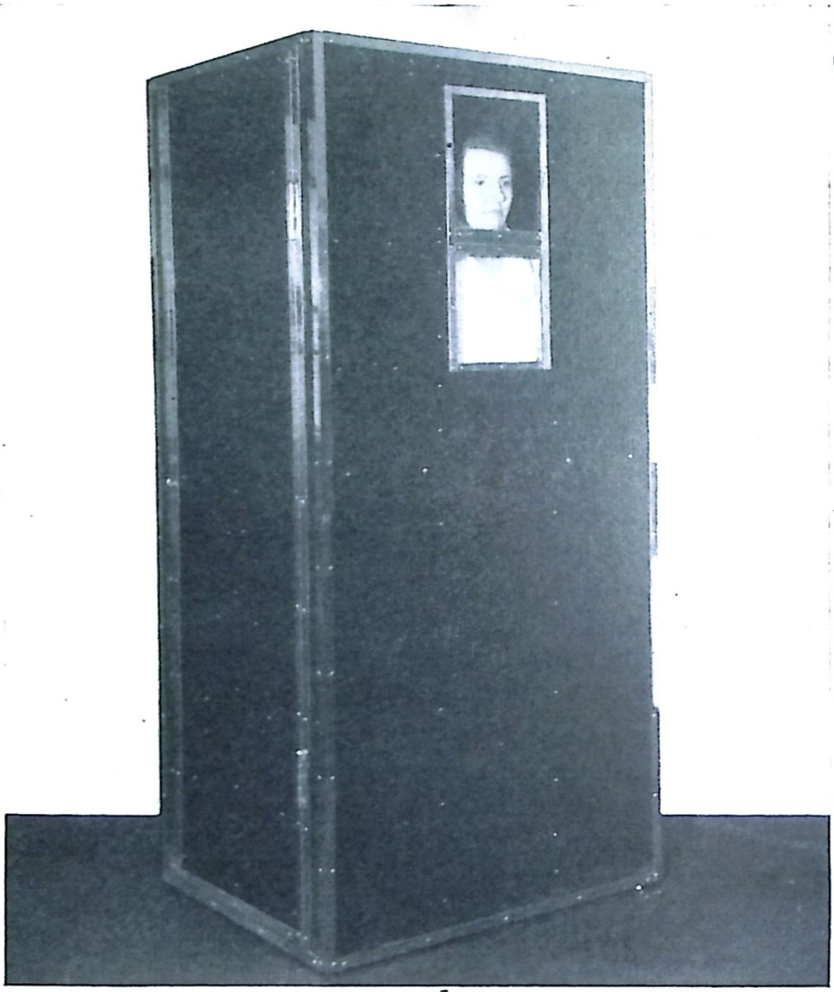


Figure No. 21
Operators lead protection booth. Absorbs all radiation

a straight line, yet they may come from any direction. So a protection screen could offer only approximately 1-5 protection.

In general, measure sales remarks concerning the ray-proof tube very carefully. The purchaser usually gets the impression from such remarks that such a tube will protect him from any secondary ray injury. As a matter of fact, there is no such radiographic tube on the market. If there was the X-rays would be absorbed before their emission from the tube. Secondary radiation is scientifically known to be the result of X-rays meeting with resistance. This happens, of course, when rays enter the patient's body. Such a ray-proof tube or leaded glass protection bowl only offers a small percentage of absorption.

The operating room should be well ventilated and the operator should avail himself of all the sunshine and fresh air exercise possible.

Again may I repeat that all high tension uninsulated wires should be kept well out of reach, and the over-head aerial should be examined frequently to be sure it is well adhered to the ceiling. Never leave the operating room with the machine running or attempt to make any repairs on the machine while the same is plugged into the circuit.

The air, due to the ozone produced in the operating room where high tension current is used, becomes more or less unfit to breathe. This condition necessitates a well-ventilated room. Use the lead glass protection bowl, even though the percentage of secondary protection is comparatively small, for it will at least protect the tube.

It is always advisable to work with the X-ray tube pointing away from the operator and to add space between the control panel and the tube, table, or chair, if possible. Naturally the greater the distance, the greater is this safety factor.

Always operate the machine and watch the patient through lead glass that has an equivalent of 1-16″ virgin sheet lead.

Before engaging the X-ray switch for operation, **Stop, Look** and **Think,** see that everyone present is out of any danger in regard to direct rays, high tension wires, or a shock of any sort. **BE SURE YOU'RE RIGHT, THEN GO AHEAD.**

Protection of the Patient

An injury to the patient who has been subjected to radiographic or spinographic work is ordinarily not so great as when they have been under the fluoroscope, or X-ray treatment. Nevertheless, danger does exist. It may be neccessary to make a number of exposures in succession from other angles. Sometimes retakes may be necessary because of incorrect technic, motion, etc.

Practically all X-ray laboratories, particularly the exclusive ones in hospitals or sanitariums have a set rule to follow in their procedures. This is done for the safety of all patients, yet their first exposure is a trial picture. The second and third exposure, are made to produce a better quality of work. It is often referred to as the "Common Rule in Practice."

In this rule due consideration is made of the following factors:

1. Idiosyncrasy
2. Age, Weight, and Complexion
3. History (referring to accidents, high temperatures, and recent X-rays)
4. Placement
5. Nature and thickness of part
6. Tube Distance
7. Kilo-Volt-Peak
8. Milliamperage
9. Exposure time.

Idiosyncrasy—quality of body or mind. This peculiarity does enter into the making of a readable picture. Often one has to deviate from an ordinary procedure to one suited to

that particular type of individual. This procedure may not be the very best, but perhaps the better for such a case.

It is always more difficult to X-ray elderly or aged individuals because of the decreased amount of calcium in the bony structures throughout the body.

If one knows the weight of the individual one has an idea of the amount of penetration to be used. Complexion refers to the blonde or brunette individual. Blondes seem to be more susceptible to the radiation than the other type. Knowing this, one can no doubt change his technic many times to make it safe for that particular type of patient.

Always inquire of the patient as to accidents and if he has had recent X-rays, inquire of what region also how many films were taken, etc. This will give one an idea of other technics used, an accurate check on milliampere seconds can be made, totaling the entire amount of energy and time given any one or series of exposures.

AFTER ANY PART OF THE BODY HAS RECEIVED THE LIMIT OF EXPOSURE IN MILLIAMPERE SECONDS AT LEAST TEN (10) DAYS OR EVEN MORE SHOULD ELAPSE BEFORE FURTHER EXPOSURE IS GIVEN.

Knowing the history of the case will often act as a guide in the placement for X-rays. This procedure saves films, adds to the safety of the patient, and results in an undelayed procedure.

Knowledge of the anatomy of the part to be X-rayed is a guide in reaching the conclusion as to what technic should be used for making a better quality of film in the least amount of time.

EXPOSURES WITHIN SAFETY LIMITS

It is absolutely necessary that the spinographer knows just how much X-ray exposure may be given a particular body area at any one time, without exceeding the safety limit rule. Though some individuals are more susceptible to the X-rays than others, 1200 Milliampere Seconds is gen-

erally accepted as the limit in radiography, based upon a focal skin distance of 15″ using a 1 millimeter aluminum filter. This value applies to all parts of the body except the head. Using the same amount of focal skin distance and the 1 millimeter filter the limit of head exposure is approximately 900 Milliampere Seconds.

Exposure limits must be varied inversely as the square of the distance, and if the focal skin distance employed is not given in the following chart, the technician or spinographer may calculate for such distances by using this chart as a basis.

Dr. E. Dale Trout, an authority on X-ray work from a medical point of view, computes the following table on a basis of 100 Kilo-Volt-Peak. These values are further based upon the production of a threshold erythema, usually calculated at approximately 300 Roentgen units. The quality of radiation is that employed in radiography and fluoroscopy. As the Kilo-Volt-Peak or penetration increases, the Milliampere Seconds have an increased margin of safety.

The number of Milliampere Seconds used is determined by multiplying the total number of milliamperes by the actual amount of time, in seconds. For instance, if 20 Milliamperes were used for 10 seconds of time, it would total 200 Milliampere Seconds.

20 Milliamperes x	10	seconds=200	Milliampere Seconds
50 Milliamperes x	4	seconds=200	Milliampere Seconds
50 Milliamperes x	½	second = 25	Milliampere Seconds
25 Milliamperes x	1.5	seconds= 37.5	Milliampere Seconds

If 100 Milliamperes were used for 1/10 of a second:

100 Milliamperes x	.1	second=10	Milliampere Seconds

The Kilo-Volt-Peak, tube distance, and the use of a proper filter are important factors and should be given due consideration in protecting the patient.

In dental radiography or skull work, or a region where the patient's hair is in line with the X-rays much caution must be used to prevent Alopecia or the "falling of hair."

Limiting the total amount of milliampere seconds in such work to 600 is a much safer procedure.

Because there is a difference in permissible Milliampere Second exposures between the head and the other parts of the body the following table is given. As there are so many combinations of factors in technic naturally the focal skin distances vary. Thus the first column covers the average skin distance in inches, the second gives the number of Milliampere Seconds that may be safely used with 1 millimeter of filtration in X-raying the head, and the third in X-raying the other parts of the body.

Focal Skin Distance (inches)	Head (with 1 mm. aluminum filter)	All parts of the body except the head (with 1 mm. aluminum filter)
15	900	1200
16	1025	1368
17	1152	1540
18	1295	1728
19	1444	1920
20	1600	2136
21	1762	2352
22	1935	2580
23	2115	2820
24	2304	3072
25	2502	3336

REMEMBER—The operator is responsible for any accidents that may occur, which are due to carelessness or ignorance.

Visitors should not be permitted to enter the operating room during the exposure work, unless there is a very good reason for their presence. If they must enter keep them away from the equipment so there will be no interference.

Fluoroscopic work is ordinarily done in a dark room. Usually all such examinations are made by the medic doing this sort of work. The technician usually prepares the patient and operates the machine, while the radiologist operates the shutters and adjusts the screen during the examination.

This particular phase of the work is always more or less dangerous. The fluoroscope must be grounded and the patient assisted about in the dark fluoroscopic room. Then too, the operator must protect himself by the use of lead glass goggles, lead rubber apron, lead rubber gauntlets, for he is always in the direct path of the X-rays.

The repeated cautions in this chapter are not intended to frighten those following this profession but rather to assist them with advice based upon experience. While the operator must assume certain responsibilities, these are no more than those required in many other vocations. Any worthwhile field of endeavor presumes a certain amount of responsibility.

CHAPTER 20

PLACEMENT SUMMARY

X-ray Markers (Patient's name, date, name of laboratory and serial number. The type of film is optional.)

a. Two in number (for flat work)

b. One to include the patient's name and date and the other the name of the laboratory and serial number.

c. The patient's name and date should be at the top of the film, while the serial number, laboratory name and perhaps type of film may be read at the side of the film, or a different combination may be arranged, just so long as these factors are contained in the marker, and a marker placed to indicate the patient's right side. Markers should be placed evenly on the film. DO NOT PLACE ANYTHING ON THE LEFT SIDE OF THE FILM WHEN FILM IS TAKEN FOR CHIROPRACTIC PURPOSES.

d. Patient's name and number to identify film. Number and name of the laboratory to recall date for retakes or comparative sets, as well as for legal purposes.

e. Marker always placed on the cassette or film at the patient's right side.

f. Markers may be adhered to cassette with adhesive or cellulose tape and when removed and replaced, it is advisable to always place them in the same spot, if possible.

g. The upper edge of the marker should be placed about $5/8$ of an inch from the outside border of the cassette.

h. Markers should read from left to right.

Stereo Marking

a. Three in number.

b. Two, the same as flat or natural film marking, with the additional marker designating the type of film and Right or Left Stereo film shift. This marker is always placed on the

film at the patient's right side indicating the Right and Left Stereo tube shift, as well as the type of film.

c. Otherwise, this marker is synonymous to that for flat or natural films.

Preparation same for both postures, supine and upright.

a. Patients are instructed to drop clothing to the waistline. Females are given gowns to be worn with the opening down the back. Males are told to reverse shirt with opening down the back. All false plates to be removed, also spectacles, hair pins, body pins, ear rings, bobby pins, necklaces, etc.

b. Note weight of patient and thickness of part of both male and female.

c. For supine positions, patient ushered to the foot of the X-ray table and instructed to sit on the end of the table.

d. Place their hands, palm down, at their sides on the table. Then instruct patient to raise his weight sufficiently to slide backwards until heels contact the top of the table. In case of children or that of very lengthy individual, it may be necessary to discount the heel and table top rule.

e. Operator then palpates first and second tubercle of the sacrum or sacral hiatus and instructs the patient to again place his hands on the table, raising his weight, shifting right or left of the median line of the table to where that point of sacral hiatus is directly over and above the median line of the table.

f. Operator then stands at the head of the table, and places his hands on the patient's scapulae.

g. Patient is then lowered to the table, the operator keeping in mind the entire spinal column and the median line of the table.

h. Operator locates the median line of the table and palpates occipital protuberance as this should be directly in line with the median line of the table.

i. Operator places his hands on the anterior portion of

the patient's shoulders and instructs the patient to raise and lower the head two or three times. If the occipital protuberance does not fall over the median line of the table the operator places his hands underneath the patient's shoulders, and using his elbows as a fulcrum, raises and shifts the patient's body, right or left, to a point where the occipital protuberance will naturally lower on the median line.

j. See that the patient's arms are parallel with his body.

k. If there is naturally a rotation in the carriage of the patient's head, and the upper cervical view is desired, the side of the patient towards which the head turns should be elevated with sand bags until the occipital protuberance and frontal groove are in line.

l. Operator places his hands on the side of the patient's head, contacts the jaw bone, tilting the patient's head, and raises the chin with the mouth open, until the lower border of the forehead and chin are on the same parallel plane as the top of the table. This may not be the very best procedure but due to irregular posture it is sometimes necessary.

m. Using the string method of alignment the operator picks up the loose end of the string and places it over the index finger of his left hand; then places the finger against the patient's occiput, and instructs the patient to open his mouth. Then keeping the string taut, he moves the X-ray tube and stands at a point where the angle of string carries on just superior to the patient's lower teeth. A 1½ inch length cork (more or less) is always used in the patient's mouth between the upper and lower teeth. Patient should not be made to open his mouth to a point where it produces tension throughout cervical muscles.

n. It is advisable to use sand bags at either side of the patient's head or a thin strap of some sort over the forehead to keep a more perfect alignment as well as to aid in the elimination of motion. Napkin paper should be used between the strap and forehead.

o. Separate the patient's feet so that each heel is approximately 3 inches from either side of the median line. On some occasions you may find it is necessary to elevate the knees by placing pillows underneath to create more relaxation. Set and cock the grid of the bucky diaphragm.

p. Instruct the patient to lie still and tell him that nothing is going to hurt him; that he will feel nothing during the exposure and may or may not hear a slight buzzing or humming of current. This depends on the type of unit used.

q. One should develop the films immediately after the exposure and should instruct the patient to keep the same position, if possible, to eliminate any delay in taking the second exposure or retake if one is necessary. It is always advantageous to develop the films immediately after the exposure, as it eliminates calling the patient in for a retake. Also, if this is practiced there will not be a lot of films to develop at the end of a day's work.

When atlas-axis specific work is carried out in the supine posture, much stress should be emphasized in making this placement. It is very easy to follow an incorrect procedure or get incorrect pictures when doing specific work in the supine position. Atlas and axis specific spinography should actually be done in the upright position, but there are times when this cannot be carried out.

Placing the Cassette for Sectional Supine Work

Sectional spinal column pictures consist of Atlas and Axis, Lower Cervical and Upper Dorsal, Lower Dorsal, Lumbar, Sacrum and Coccyx.

a. 8 x 10 films ordinarily used.

b. Atlas and Axis film placed with condyle area in the center of film. Everything equal this should clearly reveal the Atlas, Axis between dental arches.

c. Lower cervical and upper dorsal — with chin elevated, mouth closed, the superior border of the cassette is placed in line with the external auditory meatus or slightly below.

This will reveal axis and balance of cervicals and usually five or six of the upper dorsals.

d. Lower Dorsal—place the inferior border of the cassette approximately 3½ inches superior to the crest of the ilium. This will ordinarily take in, at least part of the first lumbar, up to and including the 5th or 6th dorsals.

e. Lumbar—place inferior border of the cassette approximately 2 inches inferior to the crest of the ilia. This should get part of the 12th dorsal including the first tubercle of the sacrum.

f. The sacrum and coccyx—have superior border of the cassette 1½ inches superior to the crest of the ilium. This will reveal at least all of the 5th lumbar down to and including the symphysis pubis.

If lateral sacrum is taken the cassette is placed with its superior border a good 2 inches superior to the crest of the ilium with a plane line of the external anterior portion, well to the edge of the film to assure a film center of 5th lumbar and sacrum.

Lateral cervicals are all made practically alike, with the patient in upright position if possible with the spine in the center of the film. Have the Atlas about three-fourths the way up on the film, and direct the central rays at right angles to the film, in line or nearly so to the external auditory meatus. Refer to written technic for placement of table for sectional work.

Placement for Sitting Upright Cervical Work

The preparation is the same as for supine posture.

Procedure

a. Tube and film must be in perfect alignment; that is to say, tube made to direct its rays to the center of the film and absolutely at right angles to same.

b. Note natural or normal carriage of the patient's head, whether or not there is rotation and tilt, or just rotation without tilt, or vice versa.

c. Instruct patient to place himself on the seat of the turn table. Of course, the operator's assistance is necessary.

d. Begin a conversation and ask him to move about, to turn his head right and left, left and right, to move his feet and then look forward. Usually the position of head relative to his body will then appear as you first saw it when the patient stood naturally. He must be told to keep the same position.

A to P Views

a. Place head horn against tilted side of head. See that occiput and frontal groove are in line parallel with and in the direct path of rays by rotating the turn table. It may be necessary to loosen the head horns to allow the patient's head to rotate with body when manipulating the turn table. Bear in mind—this rotation should not place any exertion on the part of the patient. When this rotation of patient's body is manually made it will force one shoulder away from the film or bucky, placing the opposite one in close proximity to the film. It is advisable to use some sort of pad, cork or similar material to place between bucky and extended shoulder.

b. Note the degree of rotation of turn table. It usually ranges from 2 to 7 degrees. Incidentally, this information should accompany the films for interpretation.

c. Manipulate the bucky to a point where it contacts the patient's head and back. In this case the Atlas should appear approximately in the center of the film. This eliminates the lower cervical vertebrae but it is usually not wise to attempt to read the lower cervicals on an upper cervical film; and by the same token it is unwise to list upper cervicals on a lower cervical and upper dorsal or full length spinal film. This is because of the manual rotation of patient's body necessary in atlas-axis specific work.

d. Place other head horn in position.

e. Note degree of bucky tilt which ranges from 6 to 12 degrees.

f. Tilt tube until tube and bucky conform to the same angle, when using the string method. Loose end of string is placed over the index finger, of either right or left hand, and then finger placed against the lower border of patient's mastoid. Instruct the patient to open his mouth, then raise or lower the tube until the angle of the string carries on just superior to the patient's lower teeth, or in line with a mark on the tube casing indicating the center of tube target. An exception to this rule may be caused by heavy low occiput or bridge work. In this event it is not advisable to move the head, but to lower or raise the tube slightly, disregarding the right angulation of the tube and string.

g. A cork is placed in the mouth between the patient's teeth and he is instructed not to move.

h. It is further advisable to instruct the patient to maintain the same placement or position, if possible, while films are being developed.

The above technic carries out the A to P stereoscopic procedure except that in this work, the tube, having been first centered is shifted right of the median line for one exposure and the same distance left of the median line for the second exposure.

i. All tube shifts, at 30 inch tube distance, are 1¼ inch. However, other tube distances may be used in stereoscopic work, by adding approximately one inch tube shift to every foot of tube distance increase.

j. For diagonal stereoscopic work the patient is first placed in a true lateral position, then rotated towards the X-ray tube to an angle of 35 to 45 degrees. The difference in degrees of angle seems only a matter of opinion as to what angle you wish to read the film from. One interpreter may prefer the 35 degree angle while another a 45 degree angle. Incidentally, rules for reading diagonal stereos in this text are based on a 35 degree angle.

k. Having obtained this angle for diagonal work the equipment is then manipulated so that the inferior border of the 8 x 10 bucky is against the tip of the shoulder, that

is the inferior border of the film rests on the shoulder. This may vary with different individuals. However, the spine must be in the center of the film. If right shoulder is closest to the film the rays pass anterior to left mastoid and posterior to the right. Tube shift is made as in any stereoscopic view.

l. The shoulder which you wish against the film, is a matter of convenience and determined by manner in which you proceed in your office.

m. Nasium work may be made either in flats or stereoscopic sets, centering the tube over and above the upper part of nasal spine. All other precision methods should be carried out. This type of picture does not seem to be generally popular at the present time but it may aid in checking, particularly laterality in your film readings.

n Vertex work may be made in flats or stereos and further aids in checking Atlas rotation. These films are made from P to A with film or cassette against the chin or A to P with film at base of occiput. When using non-shockproof equipment it is not advisable to take them A to P. Insofar as the analysis is concerned the same objective is reached from either view. In any event the lower border of the cassette will rest on or in contact with the jugular notch or clavicle. Distortion is a negligble matter here as there is but little extension of the chin.

o. In PA vertex work the rays are driven approximately at a 25 degree angle, superior, downward, and anterior to a horizontal plane line of mastoid processes. All caution and precision methods are used.

Conversing with the Prospective X-ray Case in Your Office

The first face to face view of such a case seems to be a correct one, so far as head carriage, posture, etc. are concerned.

a. If case decides on immediate X-ray note the position in which he carries his head. This notation is written on a technic card. Always file technic cards for future reference.

b. The ordinary book work is then carried out in so far as what region or regions are to be taken, case history, etc.

c. Proper markers with name plate are then made up.

d. Case is ushered to the dressing room and instructed as to preparation. At the same time a sort of friendly conversation is started in an attempt to eliminate any embarrassment and to make them feel at ease.

e. Card and marker is given the operator.

f. If possible, acquire the services of a female assistant. She will be of great help in X-raying the case, and too, the fact that she is there helps to place the case at case.

CHAPTER 21

X-RAY RECORDS

(Comparative Sets)

Regardless of the amount of radiographic or spinographic work done, a well organized record system is indispensable. Identification of the film is made possible, technic remarks, case history, etc., eliminating embarrassment in retakes; also enables the operator to produce a better quality of work.

When a case is referred to the laboratory the first time, enter all data on a record card: date, a serial number, previous X-rays, accidents, high temperature, whether or not they have had Chiropractic, region or regions to be exposed, posture and view, type of films, patient's weight or thickness of part, technic (both machine and darkroom procedures), remarks, etc. If more than one person is actually doing the work a technician's name should be added to the card.

Such records should be filed alphabetically and perhaps a card for the name, number, and who referred the case could be used to good advantage. If only a small amount of X-ray work is done perhaps the day book is sufficient.

Though it is the custom of many laboratories to give the films out promiscuously, it is not a good idea. It may cause some future difficulty. They should be the property of the laboratory or a part of the doctor's record and should remain in fireproof cabinets or be in the possession of the person in charge of the case. A complete written report should always be sent to the doctor with suggestions so far as X-rays are concerned.

The keeping of records as to machine technicalities and placement procedure has had little place in Chiropractic Spinography to date. The recent development of precision X-ray equipment makes possible comparative spinographic work. Heretofore, X-rays were made to read practically ir-

regardless of naturalness of posture or direction of rays. If a retake was needed at a later date specifically to check on progress of the case in respect to the correction of malpositioned vertebrae, etc., little attention was paid to duplicating postural or machine technicalities. Naturally obtaining a true comparison of radiographic views was practically impossible. Where work is centered mainly in the upper cervical region and with the ordinary X-ray equipment, it is almost impossible to do scientific work and absolutely impossible to do comparative X-ray work, especially concerning placement procedure unless some sort of record is maintained.

In designing spinographic placement equipment, it has been our constant aim to build around the idea of shadowgraphing the patient in his natural posture. Of course, there isn't any one posture that is constant at all times but it is up to the operator to observe his patient closely before the X-ray procedure and see that the X-ray is taken with the patient in his most natural posture.

If the patient's posture is recorded when the X-ray is made as well as the machine technicalities, that is: time, KVP, MA, tube distance, type of tube, etc., it is possible with the proper and adequate equipment to again duplicate the machine technical procedures. This is all very important in X-ray work, particularly of the upper cervical region. If we wish to obtain an accurate X-ray of the Atlas, Axis, and occiput from an analytical standpoint we must keep in mind the condyles and perhaps the occiput as a constant in precision alignment. If the patient is placed under Chiropractic care and there has been an actual change in the alignment of the vertebra, records will reveal this when alignment of constant points are again made.

Keeping records of the entire X-ray procedure is a most valuable aid in the production of better spinographs, ones which are consistently accurate both from an analytical and definition standpoint.

X-RAY TECHNIC RECORD

VIEW	K. V. P.	M. A.	T. D.	SEC.	TUBE
A.P.-Nat.					
Lat.-Nat.					
Vertex Flat					
A.P.-Stereo					
Diag.-Stereo					
Vertex St.					
Nasium					

Age Weight

Devel. Time Temp.

Previous X-rays

Operator's Remarks

TILT

ROTATION

Film No. .... Date ....

Name ....

....

....

Referred by ....

....

Figure No. 22
Technic record file card

POSTURE RECORD

A.P. NAT. A.P. STEREO

Seat Position..........R..........L..........Fr..........Bk..........
Body Rotation..........R..........L..........Degree..........
Cassette Height..........Angle..........Degree..........Fr..........Bk..........
Tube Height..........Angle..........Degree..........Fr..........Bk..........

LATERAL NATURAL

Seat Position..........R..........L..........Fr..........Bk..........
Body Rotation..........R..........L..........Degree..........
Cassette Height..........Angle..........Degree..........Fr..........Bk..........
Tube Height..........Angle..........Degree..........Fr..........Bk..........

DIAGONAL STEREO.

Seat Position..........R..........L..........Fr..........Bk..........
Body Rotation..........R..........L..........Degree..........
Cassette Height..........Angle..........Degree..........Fr..........Bk..........
Tube Height..........Angle..........Degree..........Fr..........Bk..........

VERTEX STEREO. View..........

Seat Position..........R..........L..........Fr..........Bk..........
Body Rotation..........R..........L..........Degree..........
Cassette Height..........Angle..........Degree..........Fr..........Bk..........
Tube Height..........Angle..........Degree..........Fr..........Bk..........

FULL SPINE

Position..........Supine..........Upright..........
Cassette Height....................Tube Height..........

MISCELLANEOUS

....
....
....

Figure No. 23
Posture record file card

In ordinary radiographic work, machine technicalities should be recorded, such as: kilo-volt-peak, milliamperage, time, tube distance, etc., also information as to age of patient, weight, whether muscular, thin, etc., and detailed remarks pertaining to placement. This record should be sent to the darkroom and there temperature of developing fluids, developing time, etc., should be taken.

With these records you are able to make a scientific analysis of your X-ray procedure and make the necessary changes in the production of the better spinograph. This same analysis should be recorded so that at a later date should that same individual return for other X-rays you will be able to duplicate machine technicalities or if another person of similar age and build, you can refer to the records and better the technic.

CHAPTER 22

X-RAY PROCEDURES

Since the advent of specific adjusting and the use of the stereoscope in the Chiropractic profession, many radical changes in our X-ray procedures have taken place. Such changes were scientifically proved and found to be a necessity. Thus today the spinograph, in precision, stands out as the keystone of the successful Chiropractor.

To facilitate the taking of correct spinographs: first view the patient when he is at ease, then make a mental picture of his posture, particularly the position in which he carries his head, now note to which side his head tilts and whether or not there is any rotation of head, relative to his body when he is standing naturally. Very often it is found that both tilt and rotation exists. However one of these directions is usually present. This can be ascertained when you secure the information necessary for your records.

A case record must always be considered as a part of the general rule of the laboratory. It should list details of previous X-rays, if any, then the operator must keep in mind the possible danger of irritation caused by too many consecutive X-rays. To know the region X-rayed and the number of films made will give you an idea of the amount of milliampere seconds used in previous work and will guide you, if arranging other technic to keep well within the milliampere second limit. This is all very essential. **BE SURE TO INQUIRE ABOUT PREVIOUS X-RAYS.**

The patient's name, address, etc. should be recorded. Sufficient conversation at this time should be made for the operator to obtain somewhat of an idea as to idiosyncrasies and peculiarities of his particular type and whether or not there is any history of trauma connected with the case.

A marker is made up including a serial number, the patient's name, and date, name of the laboratory, also the type

of film (referring to flat or stereoscopic pictures). Remember, a film with no marker is valueless because one would not ordinarily know which was the right side of the patient or to whom the films belonged.

This marker usually consists of an aluminum shield, supporting lead letters and numerals, just a bit of inexpensive equipment, yet very important, particularly to the Chiropractic technician. Once the name, number, date name of laboratory and type of film is shadowgraphed on the film, there is no danger of making a mistake in getting the films mixed. To include in the marker the name of your laboratory is a good idea from the standpoint of legality, as well as from the point of advertising.

To eliminate variables, create constants. Premises are formed by constants, not variables. So to arrive at a definite conclusion, one must proceed from a basis of constants.

Now comes the part in our procedure which has a direct bearing of vital importance on our efficiency in securing accurate and natural spinographs. Instruct the patient how to prepare for precision placement; as proper alignment of tube and film is the only manner in which the Spinographic technician can correctly proceed to arrive at a correct spinal analysis.

It is interesting to know that improper placement may not only cause incorrect plane lines, wedges and misalignments on the film, but also curvatures and rotations that may not exist (if they do they may appear in the opposite direction). This naturally results in an erroneous listing. So precision equipment plays a very important part here and makes it possible to then get the maximum result in your X-ray work.

To eliminate any embarrassment and create an absolute understanding, instructions as to how the patient must prepare should be given clearly. Once a patient becomes embarrassed, he is more or less tense, and then you will have difficulty in getting a natural spinograph. This is particularly true in specific work.

Ask patient to remove hair pins, earrings, bobby pins, brooches, and false plates, if any, and then to remove the clothing to the waist line. Female patients are given a clean gown to be worn with the opening down the back while the male patient is asked to turn his shirt around. During the time the patient is preparing, the machine is put in readiness. Usually two markers are fastened to the cassette. One including the serial number and perhaps the name of your laboratory is placed to indicate the patient's right side. The other should be at the top of the cassette, bearing the patient's name and the date. Use adhesive or cellulose tape to temporarily fasten the markers to the cassette. Be sure to keep markers in good alignment on cassettes. However, in stereoscopic work it is advisable to fasten the marker permanently to the cassette indicating the Right and Left stereo films. Place this at the patient's right side. The same cassette may always be used for that particular type film. This saves time in your procedure.

After patient has prepared himself, he is ushered from the dressing room, weighed and a recheck made of the machine setting to assure the proper technic. If any testing of the machine is necessary do this before placing the patient.

Supine Posture

Permit me to repeat that when making exposures in the supine position first instruct the patient to sit on the foot of the table and raise his weight with his hands, sliding back in a sitting position until his heels rest on the table. Then he is again asked to raise his weight slightly so that you may place him in such a way that the tubercles of the sacrum are directly over the center or median line of the table. It is not advisable to attempt to palpate the patient's sacrum from the head of the X-ray table. Always stand to the side, and palpate from the superior downward—over the tubercles or hiatus of the sacrum.

When the patient is centered ask him to place his hands in his lap while the operator, standing at the head of the table, places his hands on the patient's scapulae supporting

the patient as he is instructed to lie down. Do not attempt to pull the patient back, only support and guide the patient as he leans back, keeping the "vertebra prominens" directly over the median line of the table. If you cause tension by pulling, when lowering the patient to the supine posture, it will tend to distort the curvatures, should there be any. There will be a tendency to straighten the spine.

Sectional spine pictures may be made in the upright position, either sitting or standing, as well as in the supine posture. Refer to cuts throughout the written technic chapter of this text.

A skillful technician never allows long periods to intervene in his procedure. He places the patient at ease with the knowledge he secured during the first step. Then by being tactful he can divert the patient's thought from his fears as there is usually a psychological reaction on the part of the patient when he comes to be X-rayed. A remark now and then, a bit of humor or perhaps a statement of explanation will help the patient to relax and enable you to secure a more natural placement. You may do all this and still retain the dignity necessary to keep the respect of the patient. The ease in which the operator goes about his work naturally radiates confidence to the patient.

As the patient lies down, he invariably swings his head to one side of the median line, which ordinarily coincides with the normal tilt as the patient stands naturally, except that it is usually exaggerated, due to the weight of the head at the point of the occipital protuberance on the table. However, it is very possible that the head may swing abnormally to the other side. If such is the case it is necessary to realign the patient's head. Palpate the position of the occipital protuberance in relation to the median line, using the Chiropractic index finger to palpate the osseous structure, use the other index finger to locate the median line of the table. A relative position of the nails will indicate the position of the protuberance with the center line. It is advisable in making this alignment for the operator to place

his hand at the superior anterior portion of the patient's shoulders, asking him to slightly raise and lower his head so that the protuberance naturally falls over the median line. This procedure may have to be repeated several times. In that event the operator raises the patient's shoulders each time, using his elbows as a fulcrum and shifts the patient Right or Left until alignment is made. Now again repeat the process of asking the patient to raise and lower his head until the occipital protuberance falls over the median line.

If, in X-raying the entire spine or spinal column on the large film, it is necessary to instruct the patient to again sit up, to re-align the sacrum with the median line of the table, then also repeat the alignment of the upper cervical area. When the Atlas and Axis are taken in the supine position it is advisable to use either a sand bag at either side of the head or a compression band over the forehead. Sand bags are preferable as they keep the frontal groove and the occipital protuberance parallel and in line with the direct rays. Sometimes this necessitates a sort of pivoting the head which may increase tension; for this reason the upright is the better procedure. The upright with the use of a turn table for aligning the patient without placing any exertion on their part whatever, will obviously obtain better results. A full spine is correctly made in the upright position but it is more difficult to get contrasty films because the viscera drops as the patient assumes an upright position.

Your previous knowledge of how the patient carries his head when he is standing naturally will help you in knowing whether the placement is correct and natural.

If a compression band is used over the forehead and tension applied, check to see if the patient's head has rolled to one side or the other. Since the direct rays are perpendicular to the median line of the table any rotation of the head, in either direction, will create distortion and elongation on the film. In other words, as you are attempting to determine the relative position of the Atlas in relation to the con-

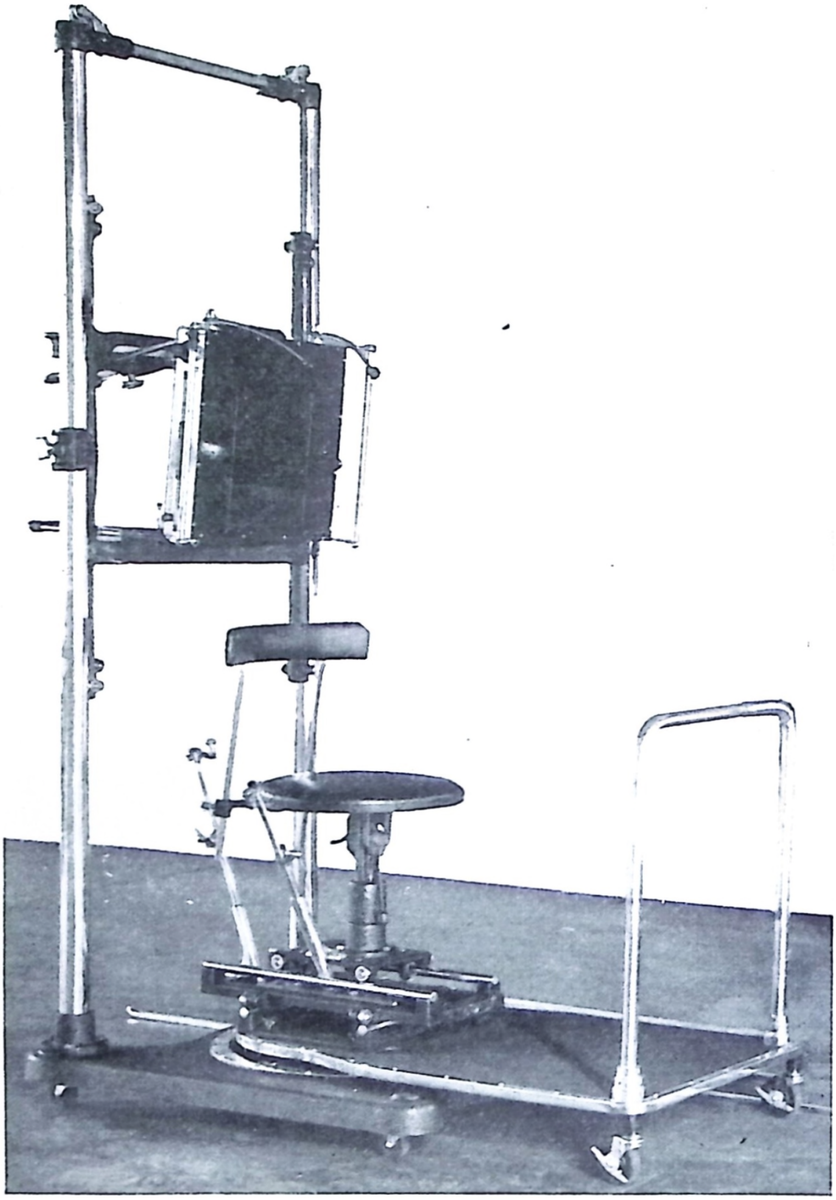


Figure No. 24
Model R Vertical Cassette Holder Bucky Diaphragm and Turn Table attached

dyles and Axis, the head must be symmetrically placed. The direct rays must bisect the chin when the mouth is closed. The lesser angling rays, when the mouth is open, are directed just superior to the lower teeth and in line with the base of the occiput. This will place the shadows of condyles, lateral masses, and a portion of the superior part of the Axis—including the odontoid process, all between the upper and lower teeth.

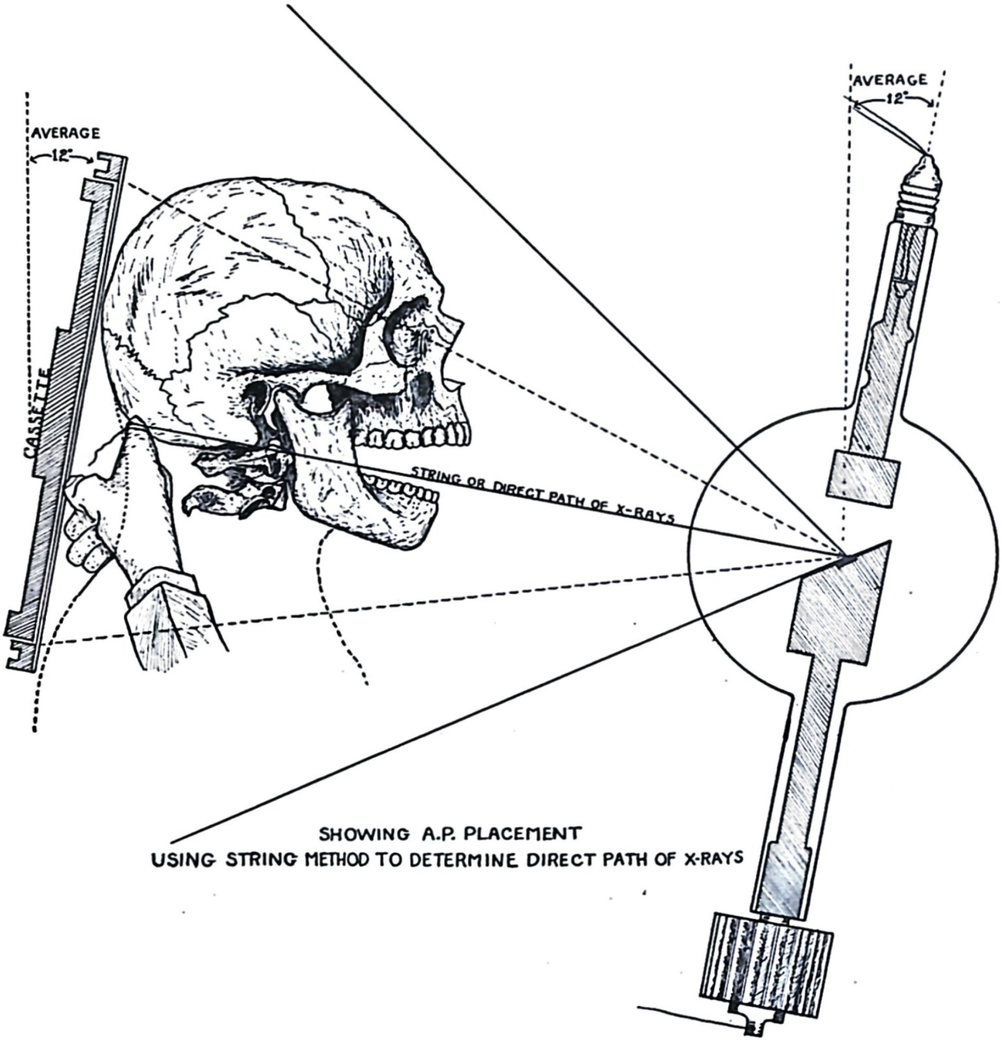
A string or cord is attached to the tube casing, or tube arm indicating the center of the tube target or focal point to facilitate aligning the tube with the patient. Refer to figure No. 25.

Flat or natural lateral exposures are never made in the supine position unless the patient cannot sit up. The string method is used in lateral work, for the same purpose as AP.

Upright Cervical Posture

For the upright cervical A to P position the patient is placed in the same relaxed manner. If using one of our vertical cassette holders which we strongly advocate, the cassette and film are placed in the holder or in the bucky diaphragm and this is projected out against the patient's head and back. The film then is not only in close proximity but also conforms more or less to the angle of the patient's head and cervical region. The orbits or forehead anatomically should be on a horizontal plane line parallel with a horizontal line of both shoulders. This may or may not appear on the film. The occipital protuberance should be in line with the frontal groove and nasal spine. Incidentally, two small protracting levels, one on the cassette holder (fastened to the 8 x 10 cassette frame or to the bucky diaphragm) and the other fastened to the arms supporting the tube, will greatly aid one in keeping the cassette and the tube on the same parallel plane.

Keeping these two parts on the same plane or parallel with one another will greatly reduce elongation or distortion. After noting the degree of angle of the cassette which



SHOWING A.P. PLACEMENT
USING STRING METHOD TO DETERMINE DIRECT PATH OF X-RAYS

Figure No. 25
Showing AP Upright Placement Using String Method to Determine Direct Path of X-rays

has been placed against the patient's head and back, the tube is then lowered and tipped up conforming to the angle of the cassette. The loose end of the string is then placed against the patient's mastoid or occiput and patient is instructed to open his mouth widely, then raise or lower the tube until it becomes at approximately right angles to the string. The string being taut should then carry on just superior to the patient's lower teeth with mouth open. However, in some few cases it may be necessary to raise or lower the tube to bring this about. A CORK IS ALWAYS PLACED BETWEEN THE PATIENT'S TEETH IN EITHER THE UPRIGHT OR SUPINE POSITION. In rare cases it might be necessary to slightly elevate the patient's chin in order that the superior edge of the lower teeth will be in close proximity to the angle of the string. This method of aligning the patient and tube for either the supine or upright postures should give an unobstructed view of the anterior portion of the foramen magnum, condyles, lateral masses and transverse processes, Axis, its odontoid and spinous process, all between the upper and lower teeth on the film. When centering the tube for laterals the direct or central rays are centered in line with the external auditory meatus or slightly below. ALWAYS REMEMBER TO KEEP THE TUBE AND CASSETTE ON A PARALLEL PLANE AND TO DIRECT X-RAYS AT RIGHT ANGLES TO THE FILM.

Placement

When one makes cervical spinographs either stereoscopic or flats, perhaps the greatest difficulty experienced in producing satisfactory results is in the placing of the patient, film and tube, rather than the type of machine or machine technicalities required. When one X-rays in the supine position stereoscopically, the table or vertical cassette holder should be perfectly level on the floor. The tube stand should be at right angles to the table top and it should travel from superior to inferior, directly over, and parallel with the median line of the top of the table. To take these views in the

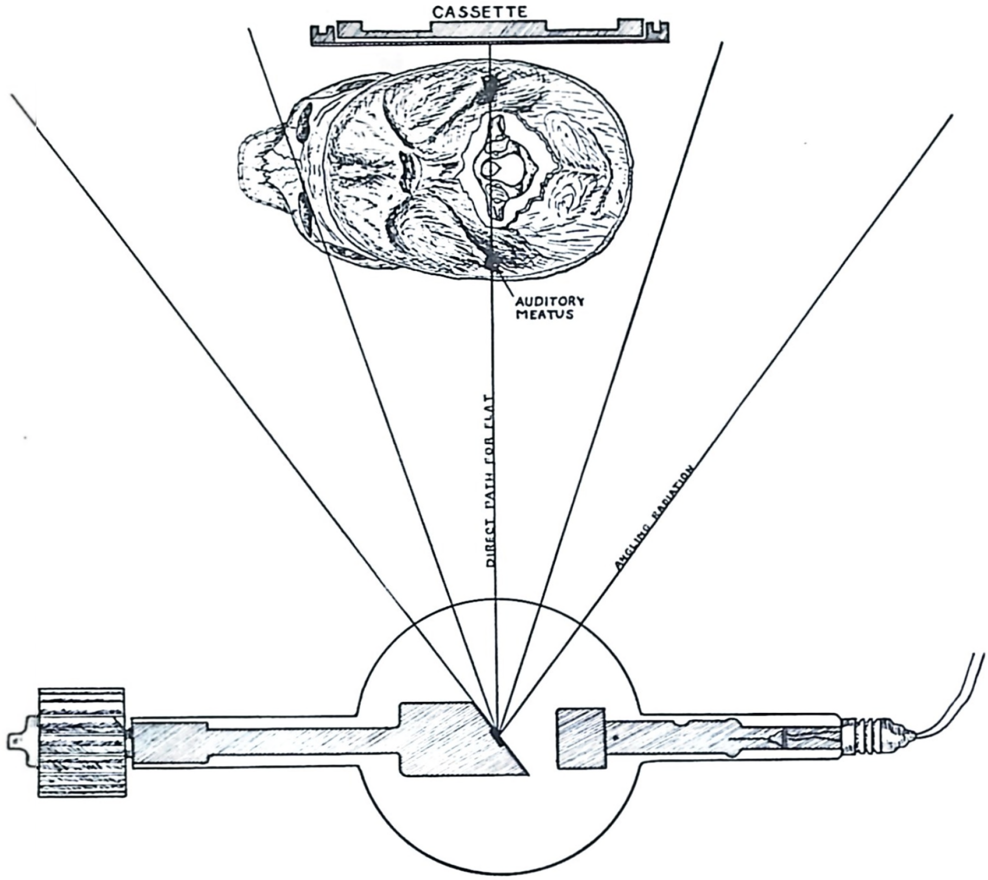


Figure No. 26

Lateral Upright Placement, showing course of direct rays

upright position, it is also necessary that the tube be parallel with and at right angles to the median line of the bucky diaphragm, face of the cassette, or the film. The vertical cassette holder track, Figure No. 6 makes it possible to proceed in a correct manner using the vertical cassette holder for sitting upright work.

Although there is a slight change in the general contour of the spine there is seldom a variance in the vertebral positions on the films of patient standing or sitting upright. However we advocate the sitting posture because the patient can be kept motionless without any difficulty during the exposures and it seems to be a more normal posture. To stand perfectly still is very difficult even though some sort of a clamping device is used for this purpose. Whatever placement is used, either the supine or upright, the patient should assume a natural, relaxed posture which is necessary for the making of upper cervical pictures.

Always remember that any part to be X-rayed should be in close proximity to the film and this part must be kept perfectly motionless during the exposure or exposures. In Stereoscopic specific work there seems to be a greater possibility of getting motion on the film than when doing the ordinary flat cervical work because of the time necessary in changing cassettes for right and left tube shifts unless an automatic plate changer is used. For this reason, one must use some sort of a head clamp or compression band for immobilization and proceed instantaneously, for motion on either stereoscopic view will not permit the two films to correctly fuse, which naturally interferes in analyzing them. THE PATIENT MUST BE MOTIONLESS THROUGHOUT THE TWO EXPOSURES. To achieve this, have the markers made up in advance and placed upon the cassettes with adhesive tape, the machine tested and set, as well as the bucky timed, before the patient is placed on the table or on the seat of the vertical cassette holder for the exposures. In this way everything will be in readiness to begin your exposure. If this method is followed, there will be no delay after you have started.

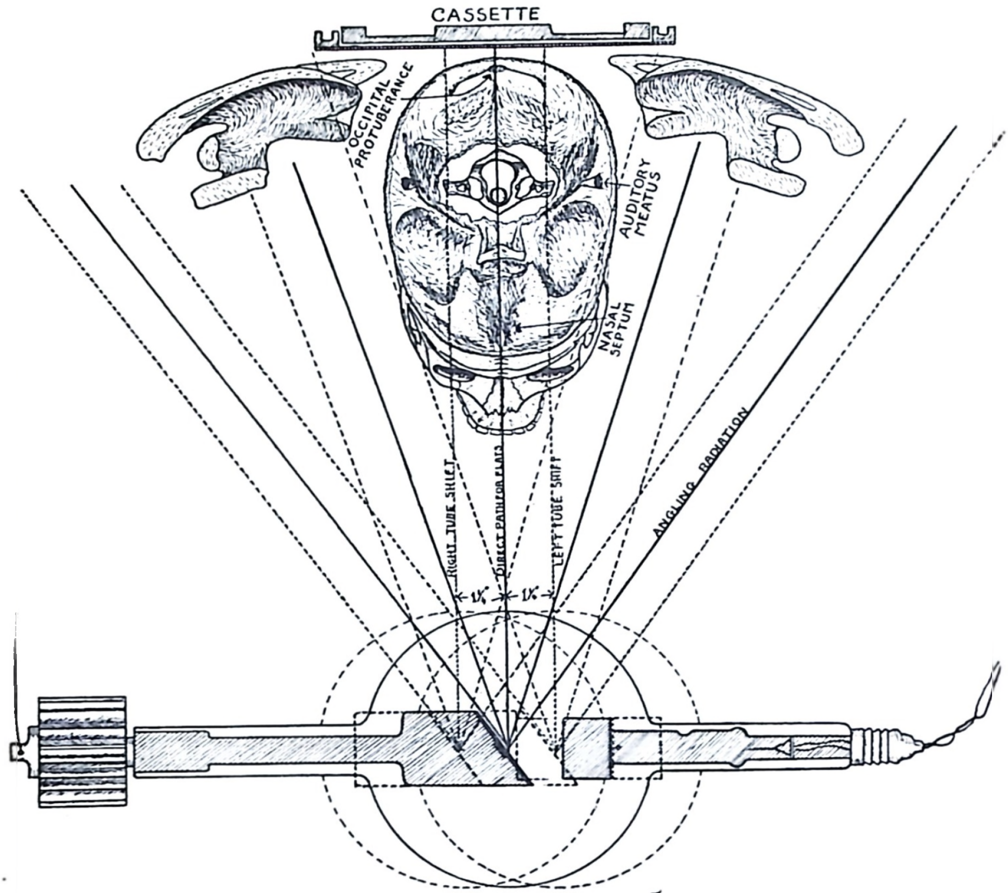


Figure No. 27

AP VIEW

Showing direct path of X-ray for A-P flat and stereo tube shifts

Alignment

We find the string or cone and beam method, with the protracting levels, very convenient when attempting to decide on the angles used in placing the tube and cassette for either the supine or upright postures. The string method has a distinct value in that the center of the tube target can be easily determined by fastening a piece of string opposite the target to the lead glass bowl which envelopes the tube, or to the tube frame itself. Small protracting levels attached respectively to the tube frame for the supine posture, on the bucky diaphragm for the sitting upright placement; to the cassette cross-frame of the vertical cassette holder; and on the tube arm itself, will enable one to produce the proper angulation.

STEREOSCOPIC SET

It is often necessary, due to anomalies and malformation, to include nine views as a complete commercial stereoscopic Spinographic set; namely, the ordinary lateral and A.P flat views, one stereo A-P through the mouth, one stereo diagonal or oblique of about 35 degrees from a true lateral position to one towards the X-ray tube, two vertex stereo views either A-P or P-A and a nasium flat view. If the patient has had a recent good A-P and lateral ordinary flat or natural film, it may or may not be necessary to retake these two views. However, when making a listing of the stereo sets, A-P and diagonals with or without vertex views, it is always advantageous to have the ordinary A-P and lateral films for comparison.

Cervical Diagonals

Again permit me to repeat that when positioning the patient (in an upright posture) for cervical diagonals rotate him approximately 35 degrees towards the tube from a true lateral position. Unusual care should be exercised to have the patient assume the same natural relaxed posture that is used for the anterior-posterior views. Make certain that

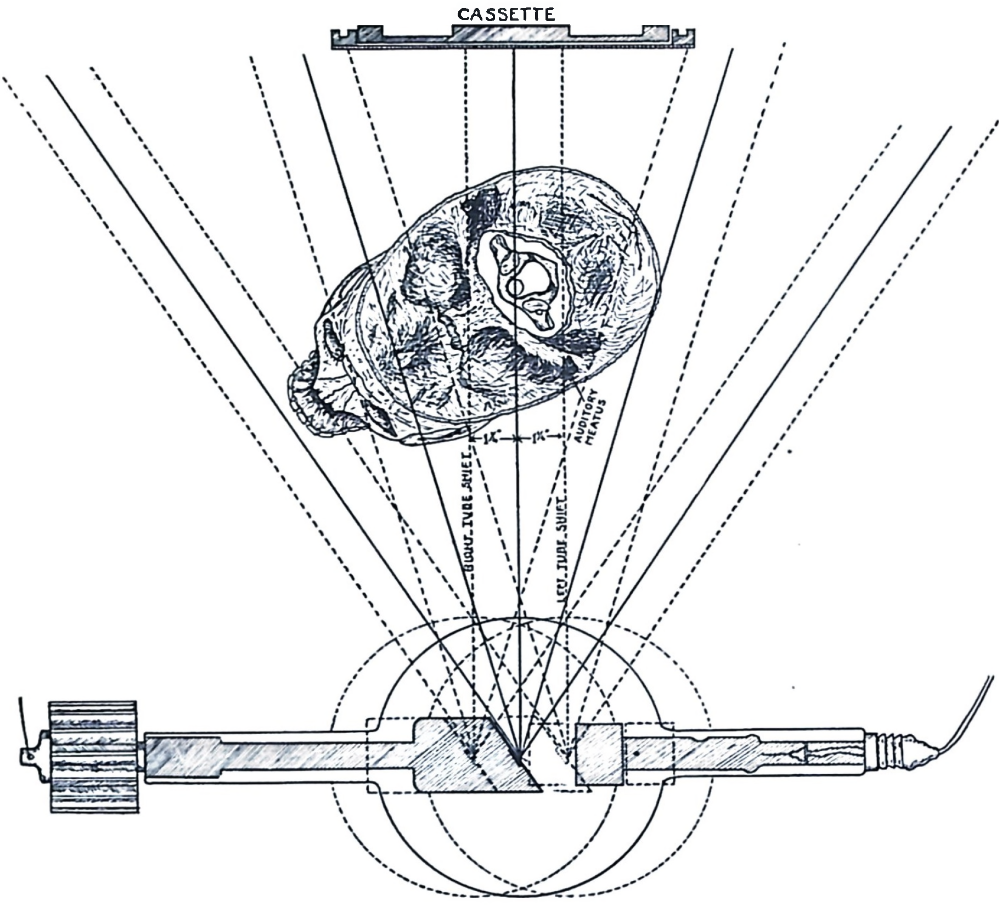


Figure No. 28
Showing course of direct rays in diagonal tube shift

any forward or backward tipping of the head is the same in both lateral and diagonal placements.

With the patient in this rotated position the cervical vertebrae are centered laterally at an approximate shoulder's length from cassette, with condyle area nearly in the center of the film. The tube is then centered with its direct rays in line with the external auditory meatus, or nearly so. This method will separate the mastoid processes on the film, and secure an unobstructed view of the condyle-atlas-axis area.

TUBE PLACEMENT FOR CERVICAL STEREOSCOPIC WORK

The technic for cervical stereoscopic work varies somewhat from that for the ordinary flat work, inasmuch as the work is done quite instantaneously and the tube is shifted for the two exposures. The tube distance is 30 inches with what is known as a 2½ inch tube separation. This means that the tube position for the first A-P stereo exposure is shifted 1¼ inch to one side of the median line, and for the second exposure the tube is shifted 1¼ inch to the opposite side of the median line. Both films or cassettes should be placed in an identical position for the different tube shifts.

To identify the tube shift on the finished film the letter "L" is placed, within the marker, on the film at the patient's right side for one exposure, and the letter "R" is placed within the marker, at the patient's right side for the second exposure.

It is essential to know the direction of tube shifts in placing the films in the stereoscope in order that the interpreter may determine the laterality just as he would if he were palpating the case or viewing it from the posterior.

TUBE TILT IN TUBE SHIFT
(Tube Shift is one-half of Tube Separation)

The tilting of the X-ray tube in stereoscopic technic has not been generally accepted and carried out in the Spinographic Laboratory, because this requires specially built equipment. In other words, one needs equipment in which the tube angles separately from the tube arm itself. Some of the new equipment has this incorporated, but in many of the older types of equipment, the tube only tilts with the tube arm. So in many instances, this becomes added work and only complicates the entire procedure with little or no advantage gained. Further, it is often found that when using some bucky diaphragms, the tube shift plus the tube tilt will cause grid lines to appear on the film. And though such films are not always detrimental or difficult to read they are sometimes quite annoying.

Unless the angle of tube tilt is in accordance with the tube shift, depth is eliminated and the film will not fuse; therefore, elongation in distortion is generally produced. However, if such manipulation of the tube is actually carried out in a precision-like manner, the percentage of depth will increase.

The tube tilt in stereoscopic work should be made in such a manner that the direct rays or central beam, after the tube is properly shifted, are centered to both films in the same manner. An ordinary localizer, attached to indicate the direction of the direct rays, or a small hole drilled through the center of the filter disk which permits a beam of light or, even a small flashlight throwing a small spot will enable one to find the center of the film or bucky. Once the angle is determined it is not necessary to repeat the process unless a different tube distance is used.

REMEMBER THAT PRECISION IN ITS ENTIRETY MUST BE CARRIED OUT

The ratio of tube shift and tube distances are as follows: (in inches)

Tube Shift	Tube Distance
2½	30
3	36
3½	42
4	48
4½	54
5	60
6	72

Markers

A marker is always placed on the A-P cervical film at the patient's right side the same as with any ordinary Anterior Posterior X-ray picture. This has been customary among X-ray technicians to determine the right and left side of the image on the film and also to identify the film.

For the lateral film the marker is not so important except for identification unless pathology exists When the right shoulder is towards the film and the marker in line with the front of the face you know when viewing the film you are looking at the right side of the case. If left shoulder is towards film, place marker in line with back of head, then you will know the left side of case will be seen.

Except for the diagonal stereos, the marker is absolutely necessary to determine the Right and Left tube shifts. The usual procedure is to place the film and cassette at the patient's right side, then the tube shifts are made according to the operator's Right and Left side as he faces the back of the cassette or Right or Left tube shift is made to that side of the patient as he faces the tube.

CHAPTER 23

SPINOGRAPHING CHILDREN

It is often difficult to get clean-cut readable upper cervical stereoscopic films of children. It is impossible to make such views of babies because they will not remain quiet during the exposures. Spinographs made under such disturbing circumstances, will not reveal the exact condition existing within the spine; therefore a true listing cannot be made. Any attempt to force them to lie still either by holding or strapping only aggravates contraction of muscles and ligaments which may increase or decrease spinal rotations.

However, if they can be kept motionless during the exposure they should be no more difficult to X-ray than adults.

When stereoscopic films are absolutely necessary it behooves the spinographer to try repeatedly to stereoscope patients when they will remain still.

One of the first essentials when making the spinograph of a child is to try to win his confidence, by letting him know you are not going to harm him. If necessary show him the machine, the tube, and the wiring, light the filament in the tube a number of times; make him think you are playing with him; get him interested—pretend it is a game.

It is advisable to have the tube centered over the film before attempting to place the child on the table, as placing him first, then moving the tube over him will cause fear.

The question often arises as to the advantage of giving the child an anesthetic for the purpose of relaxing and keeping him quiet during the exposure. This is not considered advisable as the elements of risk are too great for the advantage that may be gained.

Due to the fact that the osseous structures of the child offer less resistance than those of the adult, extreme care must be taken when deciding the spinographic technic so as not to penetrate, but merely shadowgraph the bone tissue.

In order to get the proper outlines of the lateral masses, vertebral bodies, spinous processes and tissues, it is advisable to use greater tube distance with sufficient kilo-voltpeak, or penetration, to make the exposure time instantaneous. The increase in tube distance with the proper amount of current and penetration will produce more detail, and if using non-shockproof equipment it will also add to the protection of the child. Inasmuch as the tube and wiring will be well out of his reach, there will also be less chance of him feeling any static electricity, which would, of course, cause him to move. However, if the machine is properly grounded practically all static will be eliminated.

Even though the X-ray table, upright chair, or vertical cassette holder is grounded some few individuals claim they feel a certain amount of static. This will in no way have any ill effect upon the patient, but will often cause him to move, and this blurs the outlines on the film.

If several exposure attempts are made when the above procedure is followed, you may still add to the protection of the child by increasing the tube target skin distance. This in turn increases the milliampere second limit.

The following exposure technic used with bucky diaphragm and double intensifying speed screens, with efficient solution, has produced very good results.

		Machine Technic		
	Tube Distance	K.V.P.	M.A.	Time
AP Flat	40″	60	25	2 sec.
Lateral Flat	40″	60	50	½ sec.
AP Stereo	30″	55	25	2¼ sec.
Diagonal Stereo	30″	50	50	¼ sec.

Using higher milliampere and fractional second of time may be further advantageous.

CHAPTER 24

PLACEMENT AND TECHNIC

New ideas, changes, and progress made in the manufacture of X-ray equipment and X-ray technic, at least in so far as machine technicalities are concerned, have passed through an evolutionary stage from its beginning up to the present time. Each year in the past has revealed progress in technic improvement and undoubtedly each year in the future will present something new, though the principle and theory of X-ray still remains as its discoverer found it.

Many factors enter into the making of an accurate readable diagnostic or analytical radiograph. Therefore, not knowing the variables existing within one's own laboratory or perhaps one's own community, the subject of technic is bound to be a very difficult subject to write about. However, the following details should be considered in any X-ray exposure procedure.

Are you aware that your automobile will operate more perfectly on a cloudy day than on a bright sunny day? Do you further realize that electric currents, (and this may apply to other factors as well), have a greater, steadier value on such days; that is, its electrical peak may be greater and less variable on such days, due to the induction because of atmospheric conditions. Likewise it is true that more quality films are produced on a cloudy day than on a bright one. The writer is in no way intimating that you should wait for a cloudy day to make your X-ray exposures, he just mentions this type of variable.

Some particular localities are more annoyed with variation in current than others. This may be due to an inferior set-up at the power plant itself, or to an overloading of equipment on the same line from the same pole transformer from which you draw your supply. For instance, ice machines, elevators, printing equipment, all interfere on an X-ray line circuit. Then too, a faulty tube, such as a gaseous

one will not permit a steady flow of current through the X-ray tube. The latter, of course, can be very readily rectified.

The characteristics of any X-ray tube play an important part in technic. A fractional difference in the width of the focal lines or perhaps a slight difference in the chemical analysis of the copper alloy of which the tube target is made are important variations. Further, there may be some difference in the durability of the tungsten button itself.

Intensifying screens are likewise important, for films are only as good as the screens make them. The amount and size of tungsten crystals within the screen's emulsion, the efficiency and the present condition of the binder which supports the tungsten crystals, perfect contact of screens and films, all promote film quality. For naturally the best results are not obtained when film and screen contact is poor. If such is the case it is no doubt due to a twist in the cassette frame itself, or there may be some indentation made within its face or a variation in the thickness of the glue or adhesive that is necessary in adhering the screens to the cassette frame.

A difference in the resistance of the bakelite and aluminum cassette faces may produce a slight variation in the quality of film as the aluminum offers slightly more resistance than the bakelite. A given technic producing a fair quality film with a certain cassette and set of intensifying screens may be as much as ten per cent inferior or even more compared with a film exposed in another cassette with another set of intensifying screens.

X-ray machines are not constructed identically in their graduations, so one may operate different from another. Physical conditions enter into the making of a good picture. For instance, fluid in dropsical conditions makes it difficult to produce readable films; painter's colic or lead poisoning in the system offers more resistance to the X-ray, naturally interfering when such exposures are made. Then of course, there is a difference in the exposure of the growing up and the adult individual and particularly so of the older patient

even though they may be of the same weight, height and thickness as there is a smaller percentage of calcium within their osseous structures. Films made of elderly people are never as contrasty and clearly outlined as of the younger individual because the films are usually over-exposed.

The writer also believes that better results in film developing may be obtained if one uses the developer made by the manufacturer from whom he purchased his films. Without a doubt, developing ingredients, amounts, etc. are made to develop a certain particular film emulsion.

Finally the writer wishes to state that the following technic has been worked out here (Palmer School of Chiropractic) in our laboratories, tested, and has produced good quality films (such as seen in the following cuts) with our own equipment and accessories. Though it may not work to your satisfaction, it will at least give you a good firm foundation on which you may build your own technic, for having made a single picture from the proposed technic, you will readily know what to do in making the second one if another is necessary.

The following two skeleton cuts, Anterior to Posterior and Posterior to Anterior, will naturally be of some assistance in the study of this work.

Anterior View

1 Frontal Bone
2 Parietal Bones
3 Temporal Bone
4 Malar Bones
5 Bony Orbit
6 Superior Maxilla
7 Bony Cavity of Nose
8 Vomer
9 Teeth
10 Inferior Maxilla
11 5th Cervical Vertebra
12 6th Cervical Vertebra
13 7th Cervical Vertebra
14 1st Dorsal Vertebra
15 Manubrium, or Handle of Sternum
16 Body of the Sternum
17 Ensiform Process
18 Clavicle
19 Scapula
20 Coracoid Process of Scapula
21 1st
22 2nd
23 3rd
24 4th — True Ribs
25 5th
26 6th
27 7th
28 8th
29 9th
30 10th — False Ribs
31 11th
32 12th
33 Costal Cartilage
34 12th Dorsal Vertebra
35 1st Lumbar Vertebra
36 2nd Lumbar Vertebra
37 3rd Lumbar Vertebra
38 4th Lumbar Vertebra
39 5th Lumbar Vertebra
40 Sacrum
41 Ilium
42 Crest of Ilium
43 Crest of Pubis
44 Ischium
45 Thyroid or Obturator Foramen, round opening of Os-Innominatum
46 Humerus
47 Lower Head of Humerus
48 Ulna
49 Radius
50 Carpus
51 Metacarpus
52 Phalanges
53 Shaft of Femur
54 Upper Head of Femur
55 Neck of Femur
56 Great Trochanter of Femur
57 Lesser Trochanter of Femur
58 Outer Tuberosity
59 Inner Tuberosity
60 Patella
61 Tibia
62 Fibula
63 Inner Malleolus (of the Tibia)
64 Outer Malleolus (of the Fibula)
65 Tarsus
66 Metatarsus
67 Phalanges

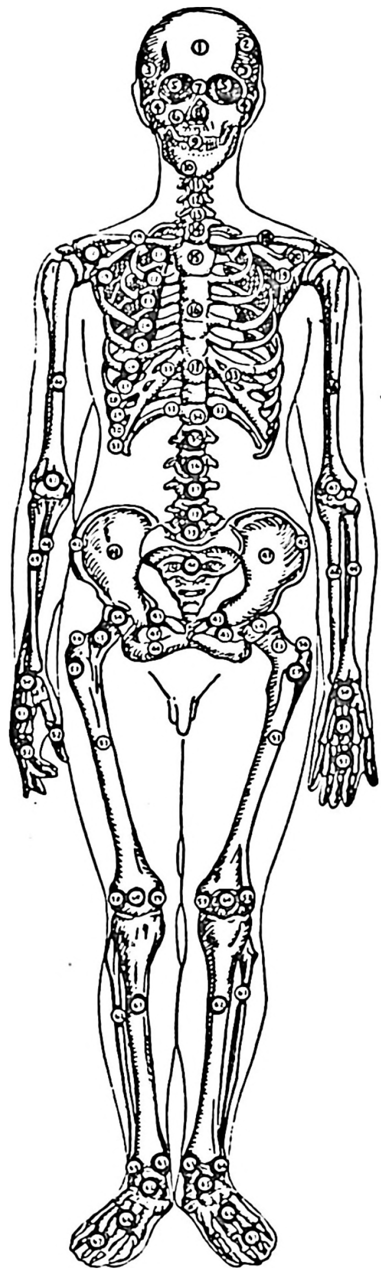


Figure No. 29
Skeleton (Front View)

Posterior View

1 Occipital Bone
2 Parietal Bones
3 Sutures
4 Temporal Bones
5 Mastoid Process of Temporal Bones
6 Inferior Maxilla
7 1st atlas
8 2nd axis
9 3rd
10 4th Vertebrae of Neck
11 5th
12 6th
13 7th
14 1st Dorsal Vertebra
15 12th Dorsal Vertebra
16 1st Lumbar Vertebra
17 5th Lumbar Vertebra
18 Ribs
19 Clavicle
20 Scapula
21 Spine of Scapula
22 Acromion Process of Scapula
23 Coracoid Process of Scapula
24 Humerus
25 Great Tuberosity of Humerus
26 Ulna
27 Radius
28 Olecranon Process of (?)
29 Carpus
30 Metacarpus
31 Phalanges
32 Sacrum
33 Coccyx
34 Ilium
35 Pubis Of Hip Bone
36 Ischium
37 Shaft of Femur
38 Head of Femur
39 Neck of Femur
40 Great Trochanter of Femur
41 Small Trochanter of Femur
42 Outer Tuberosity of Femur
43 Inner Tuberosity of Femur
44 Inter Condylar Notch of Femur
45 Tibia
46 Fibula
47 Os Calcis
48 Metatarsus
49 Phalanges

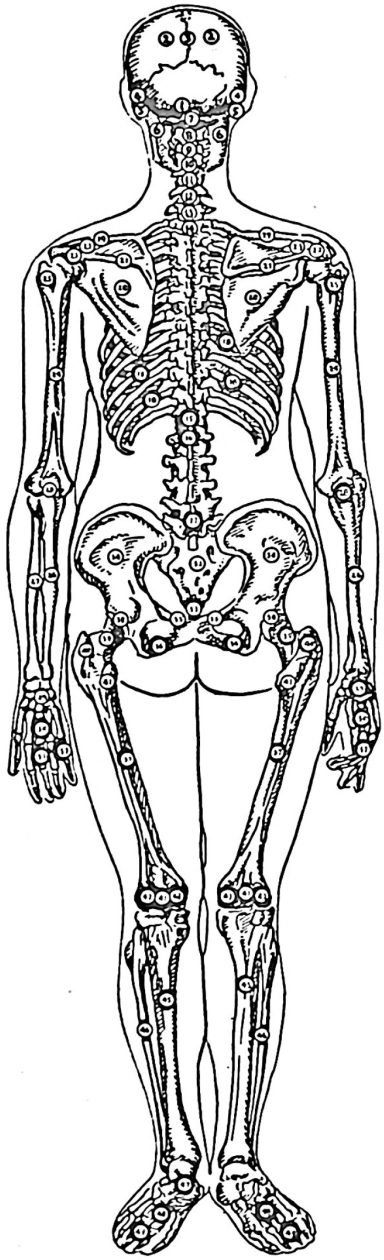


Figure No. 30
Skeleton (Rear View)

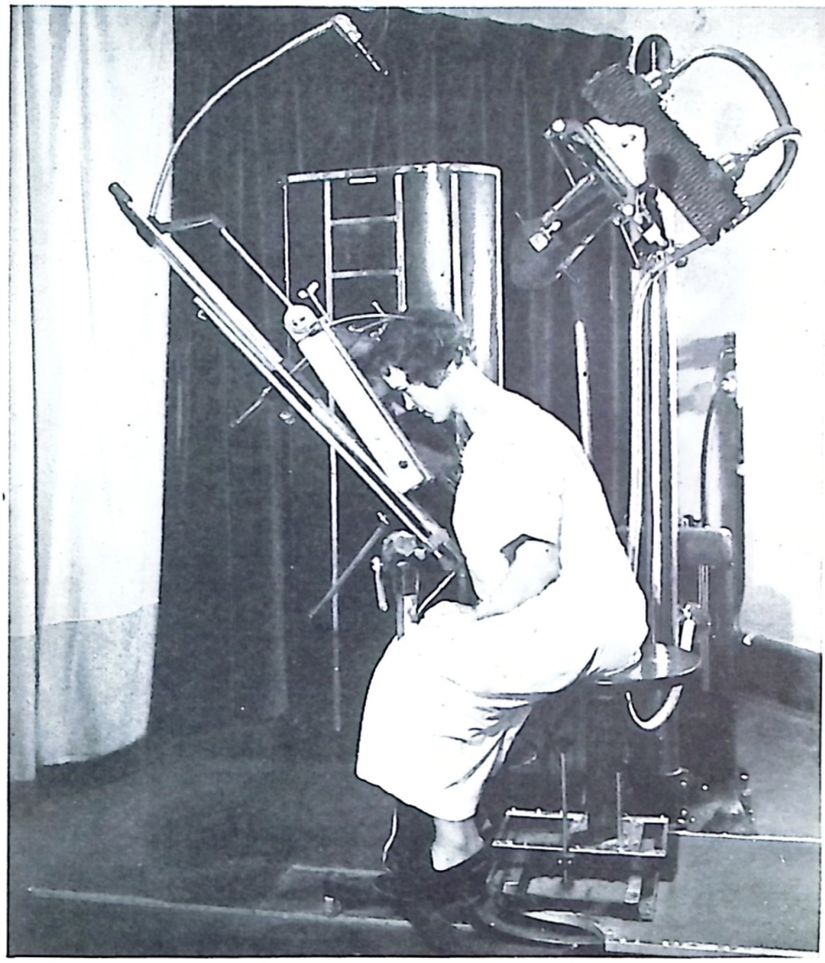


Figure No. 31

FRONTAL SINUSES

Technic (With Screens)

With Bucky				Without Bucky			
M.A.	KVP	Time	Tube D	M.A.	KVP	Time	Tube D
10	78	6 sec.	36″	10	70	5 sec.	36″
25	75	2¼ sec.	36″	25	72	2 sec.	36″
50	75	1¼ sec.	36″	50	72	1 sec.	36″
100	75	¾ sec.	36″	100	72	½ sec.	36″

Figure No. 32

FRONTAL SINUSES

Film — 8x10 film used placed lengthwise to patient's head.

Preparation—none necessary.

Posture—in either the upright or prone position with the forehead or nose touching the bucky or cassette. Always put the bridge of the nose in the center of the cassette. Immobilizing apparatus should be used to prevent movement.

Tube Position—The central rays should be directed toward the center of the cassette penetrating the skull just above the floor of the cranial cavity.

Description of the film—The negative reveals an unobstructed view of the contour of the sinus walls and the upper half of the orbital cavity. A portion of the antrum is obstructed somewhat by the shadow of the petrous portion of the temporal bone.

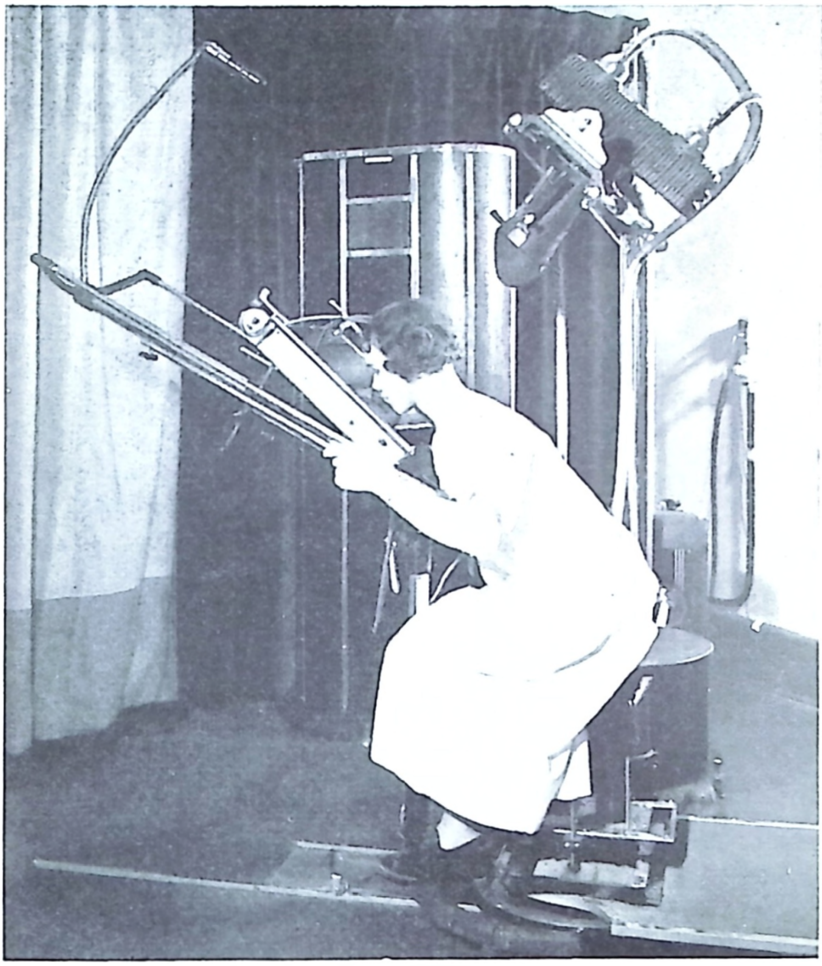


Figure No. 33

MAXILLARY SINUSES — PA View

Technic (With Screens)

With Bucky				Without Bucky			
M.A.	KVP	Time	Tube D	M.A.	KVP	Time	Tube D
10	78	6 sec.	36″	10	70	5 sec.	36″
25	75	2¼ sec.	36″	25	72	2 sec.	36″
50	75	1½ sec.	36″	50	72	1 sec.	36″
100	75	¾ sec.	36″	100	72	½ sec.	36″

Figure No. 34

MAXILLARY SINUSES — PA View

Film—usually an 8x10 film is used placed lengthwise to the patient's head.

Preparation—none necessary.

Posture—either upright or prone with chin and nose touching bucky or cassette, the tip of the nose approximately in the center of the film, head immobilized.

Tube Position — central rays directed to the center of the cassette. The rays will come just superior to the cranial floor, missing the heavy bones of the skull.

Description of the film — The negative reveals the contour of the frontal sinus walls, septa, complete orbital walls, and antrum and maxillary sinus walls. The shadow of the petrous portion of the temporal bone falls below the antrum.

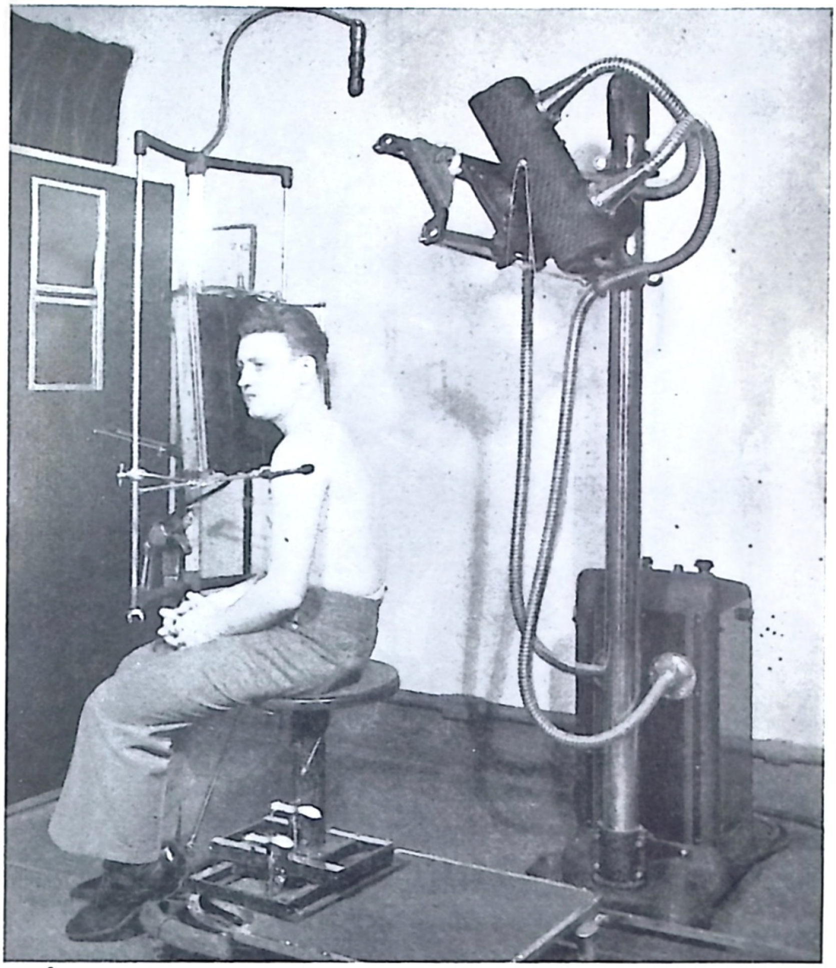


Figure No. 35

MASTOID PROCESS

Technic (With Screens)

With Bucky				Without Bucky			
M.A.	KVP	Time	Tube D	M.A.	KVP	Time	Tube D
10	55	7 sec.	30″	10	50	5 sec.	30″
25	53	3 sec.	30″	25	50	2 sec.	30″
50	55	1½ sec.	30″	50	50	1 sec.	30″
100	55	¾ sec.	30″	100	50	½ sec.	30″

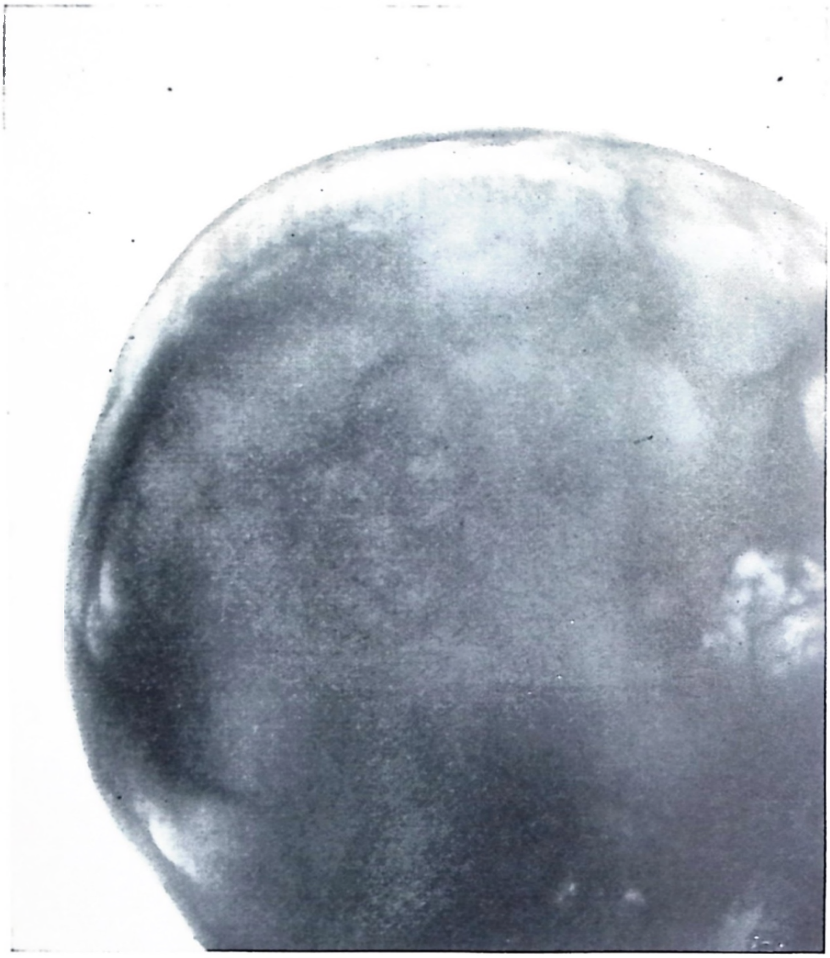


Figure No. 36

MASTOID PROCESS

Film — usually an 8x10 is used placed lengthwise to the patient's head.

Preparation — none necessary.

Posture — Patient in either the upright sitting or prone position, patient's face turned allowing the side of the face to be against the cassette or bucky, the mastoid in question, about in the center of the cassette with the pinna of the ear turned forward.

Tube position—center of the tube so that the central rays are directed at the center of the cassette or film, striking the head obliquely from the superior.

Description of the film — reveals the auditory canal and the contour of the mastoid cells with their dividing walls.

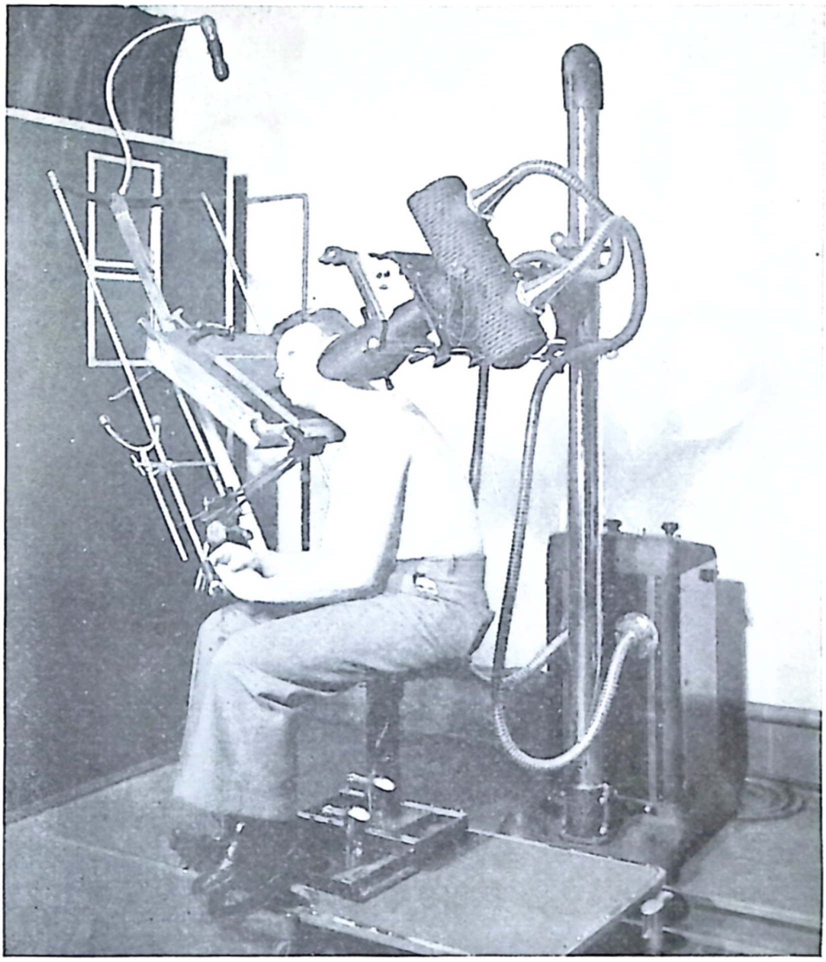


Figure No. 37

MANDIBLE

Technic (With Screens)
Without Bucky

M.A.	KVP	Time	Tube D
10	55	2 sec.	30″
25	55	¾ sec.	30″
50	55	½ sec.	30″
100	55	1/5 sec.	30″

Figure No. 38

MANDIBLE

Film — 8x10 placed lengthwise to the patient's head.

Preparation — none necessary.

Posture — either reclining or upright, upright posture advisable. The jaw to be taken should be placed next to the cassette, patient's chin elevated from the chest, resting as far up on the cassette as the position of the cassette against the shoulder will permit. The jaws should lie in a parallel plane to the cassette, center of the jaw placed horizontally at the center of the cassette.

Tube position — placed so that the central rays will strike the mid-region of the jaw and the center of the cassette.

Description of the film — reveals contour of most of lower jaw, including route-canals and contour of both upper and lower molars and cuspids.

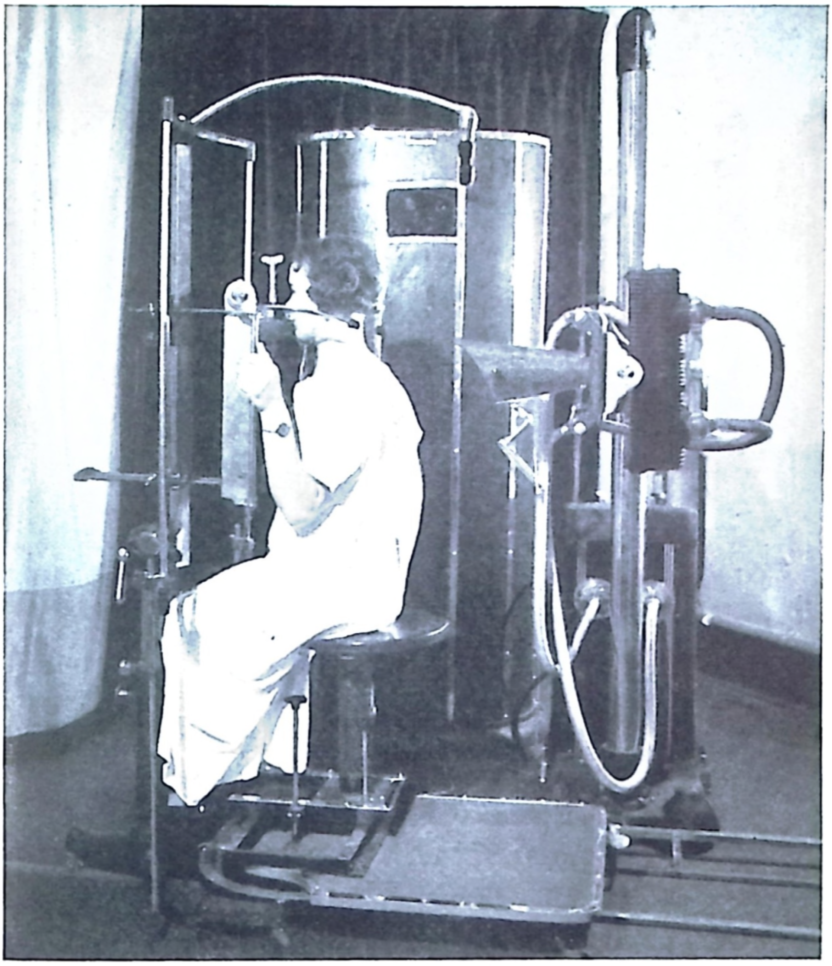


Figure No. 39

CLAVICLE — PA View

Technic (With Screens)

With Bucky				Without Bucky			
M.A.	KVP	Time	Tube D	M.A.	KVP	Time	Tube D
10	55	6 sec.	36″	10	50	5 sec.	36″
25	53	2½ sec.	36″	25	50	2 sec.	36″
50	55	1¼ sec.	36″	50	50	1 sec.	36″
100	60	¾ sec.	36″	100	55	½ sec.	36″

Figure No. 40

CLAVICLE — PA View

Film — If for fracture, 8x10, placed lengthwise with patient's body; if for any other purpose, a 14x17 is advisable to make possible comparative studies.

Preparation — clothing removed from the area to be X-rayed.

Posture — If using an 8x10 film either the supine or upright position is used. The patient is placed, facing the cassette, with the head turned away from the clavicle to be X-rayed and placed against the bucky or cassette so that both extremities will show on the film. If using a 14x17 film, either the prone or upright position may be used, preferably the upright; the patient facing the cassette or bucky, with the episternal notch in the center vertically. Both arms should be in the same position.

Tube position — central rays directed at the episternal notch perpendicularly to the cassette.

Description of the film — reveals contour of clavicle, its articulation at the sternum and its articulation with the acromion process of the scapula.

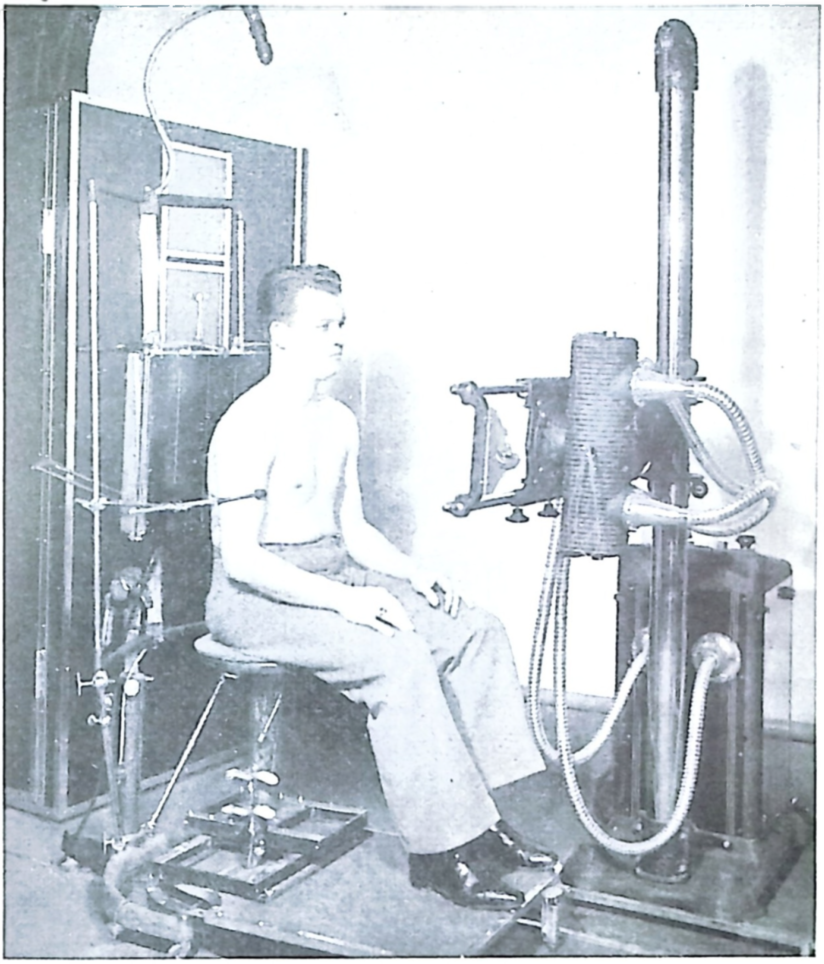


Figure No. 41

SHOULDER — AP View

Technic (With Screens)

With Bucky				Without Bucky			
M.A.	KVP	Time	Tube D	M.A.	KVP	Time	Tube D
10	65	7 sec.	36″	10	60	5 sec.	36″
25	65	3 sec.	36″	25	60	2 sec.	36″
50	65	1½ sec.	36″	50	60	1 sec.	36″
100	65	¾ sec.	36″	100	65	½ sec.	36″

Figure No. 42

SHOULDER — AP View

In radiographing the shoulder joint several points must be considered, the most important being the purpose. In fractures, an 8x10 film is used. The patient is in either an upright sitting or a supine posture, so placed that the head of the humerus will appear in the center of the film. The tube is placed so that the central rays are directed perpendicularly to the center of the film or cassette, thereby centering the rays on the head of the humerus. When the patient is in either the sitting or supine posture the arm and forearm are at the side with the palmar surface of the hand facing forward.

Occasionally where the coracoid process is fractured or where other angles are necessary a P to A view may be of value.

In almost any type of fracture a stereoscopic view will give a much greater amount of information. An incomplete epiphysial fracture may be difficult to specifically locate as to degree of depth, etc. The third dimension views make this possible. We suggest using a 30" tube distance with the corresponding 2½ inch horizontal tube shift, 1¼ inches either side of the median line.

When looking for conditions other than fractures we recommend using a film large enough to include both shoulders, preferably a 14x17.

So often in X-raying just one shoulder and attempting to determine irregularities, malformations, etc., there is a possibility of such being congenital in nature and a question as to it having any bearing upon the incoordination existing. In taking both shoulders one can make a comparison and usually arrive at an accurate conclusion. When taking both shoulders, either stereoscopically or naturally, the film is placed about 2 inches above the superior border of the shoulder with the tube centered over the episternal notch, using a 48 inch tube distance with the necessary horizontal tube shift of 4 inches, 2 inches either side of the median line. The arms should be at the patient's side with forearms over and across the abdomen.

SHOULDER — PA View

Refer to Figure 41, Page 213 for reverse placement

Technic (With Screens)

With Bucky				Without Bucky			
M.A.	KVP	Time	Tube D	M.A.	KVP	Time	Tube D
10	65	7 sec.	36″	10	60	5 sec.	36″
25	65	3 sec.	36″	25	60	2 sec.	36″
50	65	1½ sec.	36″	50	60	1 sec.	36″
100	65	¾ sec.	36″	100	60	½ sec.	36″

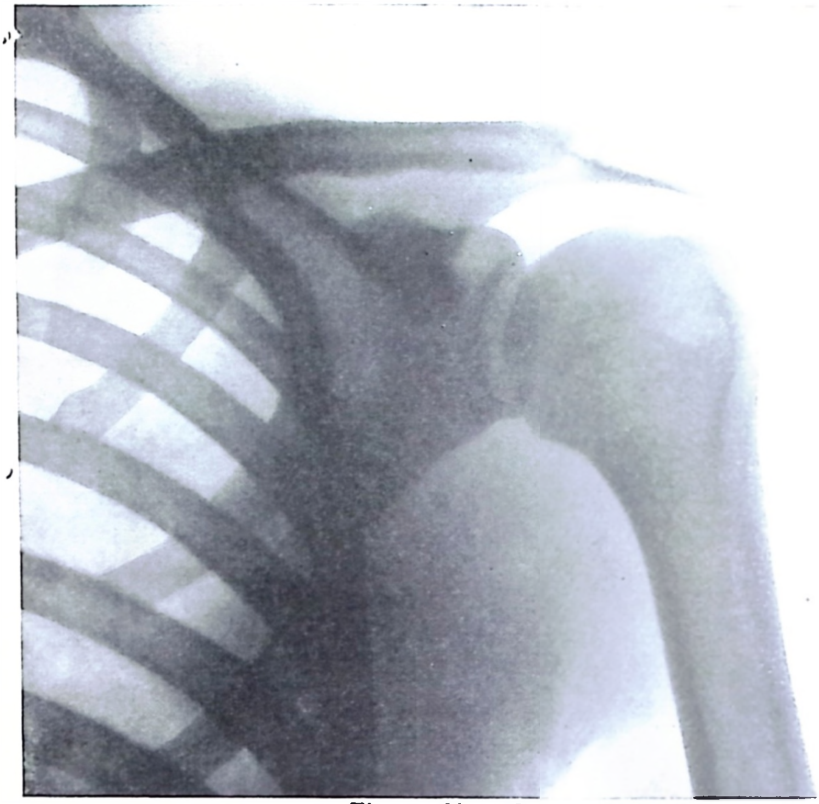


Figure No. 43

SHOULDER — PA View

Film—usually an 8x10, unless a comparison is to be made, then use a 14x17.

Preparation — clothing removed from area to be X-rayed.

Posture — either prone or upright, patient placed so that the shoulder will appear in the upper and outer one-third of the film. The patient's face is turned away from the shoulder to be X-rayed, arms at side, and palmar surface of the hand facing inward. The patient must not breathe during the exposure. If both shoulders are to be shown, a 14x17 film is used. Place the cassette so that the episternal notch appears in the center, and so that the top of the film comes about even with the 5th cervical vertebra.

Tube position — central rays directed at the head of the humerus and at right angles to the cassette or bucky. If both shoulders are X-rayed, center rays at the episternal notch.

Description of the film — shows contour of the outer half of the clavicle, head of the humerus, epiphysial lines in some cases and epiphysial separations in young individuals, contour of upper part of the shaft of the humerus and somewhat that of the glenoid fossa.

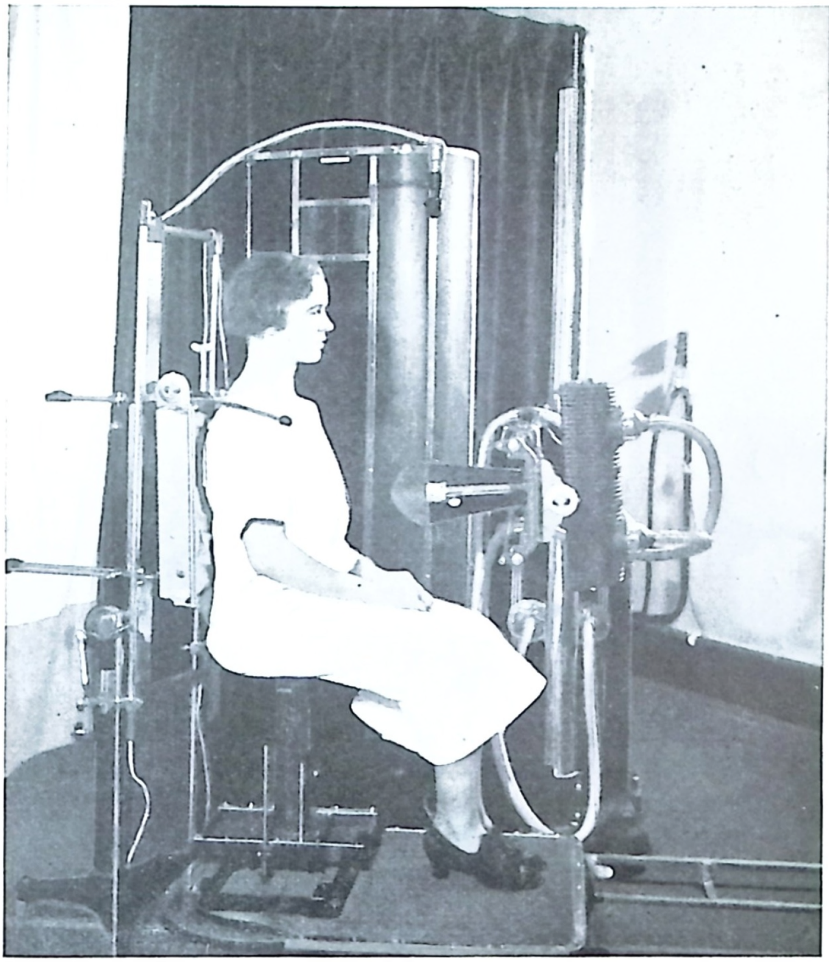


Figure No. 44

HUMERUS — AP View

Technic (With Screens)
Without Bucky

M.A.	KVP	Time	Tube D
10	50	2 sec.	36″
25	50	¾ sec.	36″
50	50	½ sec.	36″
100	50	¼ sec.	36″

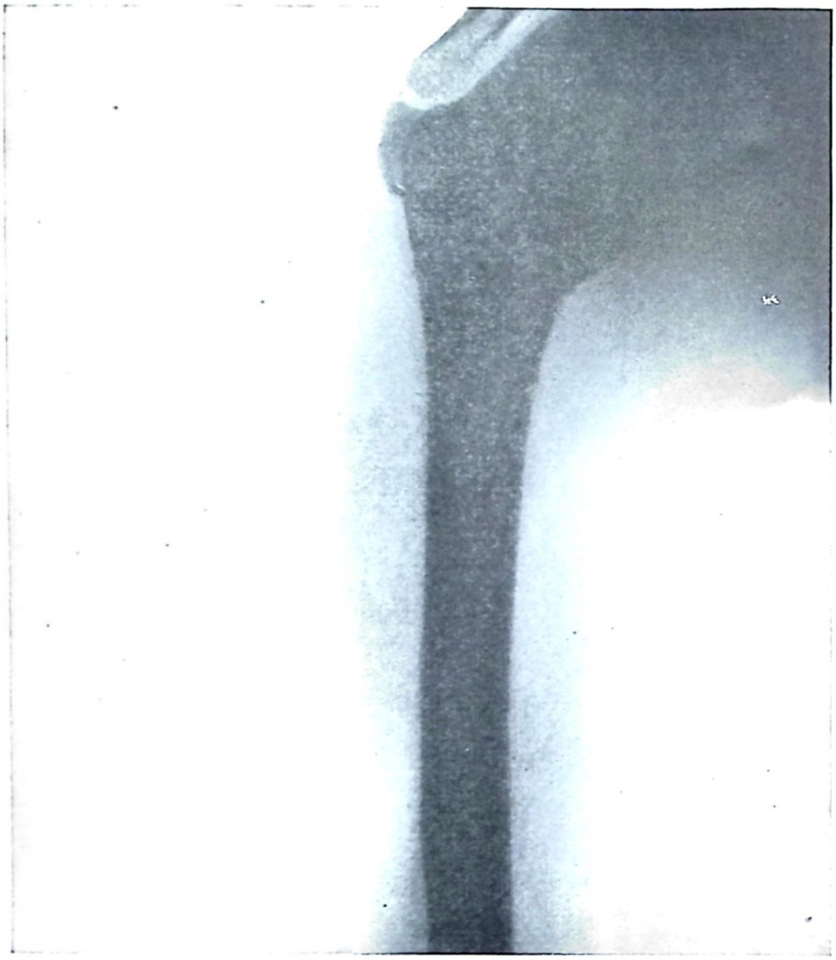


Figure No. 45

HUMERUS — AP View

Film — for fracture usually an 8x10 is used.
Preparation — none necessary.
Posture — Patient in either the upright or supine position, placed so that one of the two extremities will show on the film as a land mark. The arm is immobilized, the palmar surface of the hand up.
Tube position — the central rays directed over the fractured area, at right angles to the cassette.
Description of film — Complete contour of the extremity and a greater portion of the shaft is shown.

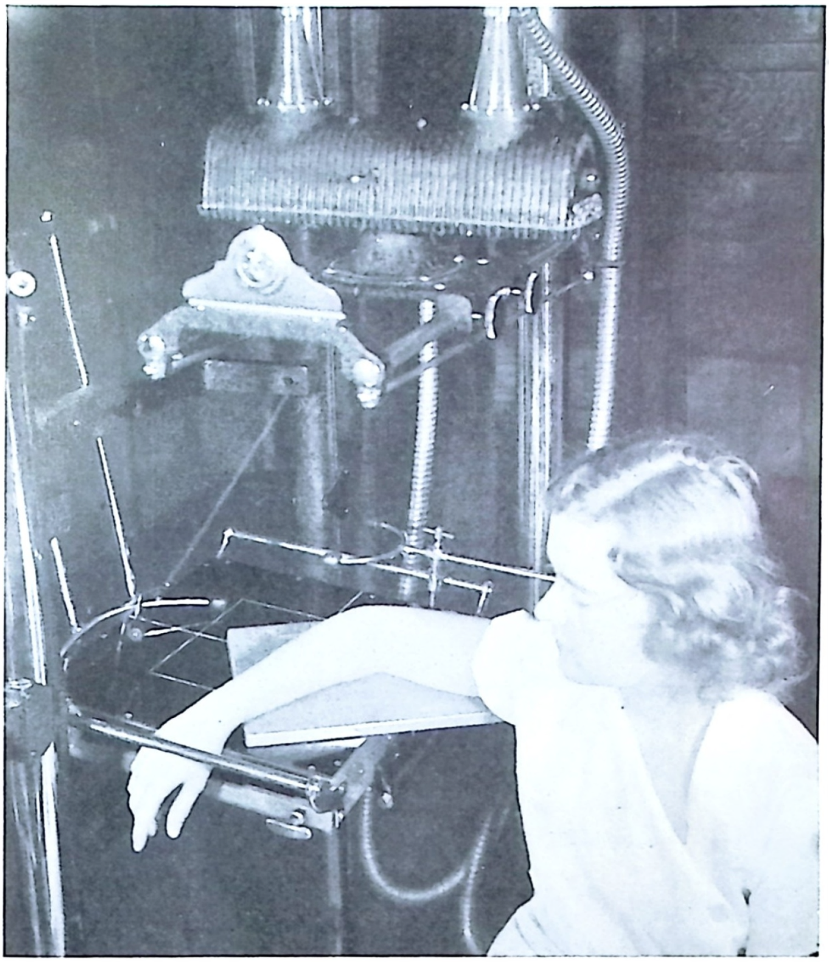


Figure No. 46

ELBOW — Lateral View
Technic (With Screens)
Without Bucky

M.A.	KVP	Time	Tube D
10	58	1¼ sec.	36″
25	58	½ sec.	36″

With Cardboard Exposure Holder

10	58	7 sec.	36″
25	58	3 sec.	36″

Figure No. 47

ELBOW — Lateral View

Film — 8x10.

Preparation — none necessary.

Posture — The patient should be in the sitting upright position. The arm and forearm are placed on the cassette rack with the palmar surface of the hand down, while the forearm is slightly inducted.

Tube position — Central rays directed at the elbow perpendicularly to the cassette.

Description of the film — The inferior portion of the humerus shows quite distinctly in its articulation in the semilunar notch. The articulating surface at the head of the radius with the humerus and the radial notch of the ulna shows the contours of the olecranon process and the radial notch.

Figure No. 48

ELBOW — AP View

Technic (With Screens)
Without Bucky

M.A.	KVP	Time	Tube D
10	55	1¼ sec.	36″
25	55	½ sec.	36″

With Cardboard Exposure Holder

M.A.	KVP	Time	Tube D
10	55	7 sec.	36″
25	55	3 sec.	36″

Figure No. 49

ELBOW — AP View

Film — 8x10.

Preparation — none necessary.

Posture — The arm is extended flat on the cassette with the palmar surface of the hand up. Sand bags are used to hold the forearm and arm motionless. The elbow should be in the center of the cassette.

Tube position — The tube is placed so that the central rays will strike the elbow at right angles to the cassette. A lead cone may be used to bring out more detail.

Stereoscopic views of the elbow joint facilitates specific interpretation. A 30 inch tube distance is used with the necessary horizontal tube shift. Stereoscopic views more distinctly abbreviate the true contour of all three dimensions.

Description of film — Revealing the true contour of all three dimensions showing the relative position of the articular surfaces of the superior extremity of the radius and ulna including the radial notch, olecranon process, corocoid process, etc., showing the inferior articulating surfaces and depressions of the humerus, also making possible true conception of the size of the space between the articulating surfaces.

RADIUS AND ULNA — AP View

Refer to Figure 48, Page 221 for similar placement

Technic (With Screens)

Without Bucky

M.A.	KVP	Time	Tube D
10	55	1 sec.	36″
25	55	½ sec.	36″

With Cardboard Exposure Holder

10	55	7 sec.	36″
25	55	3 sec.	36″

Figure No. 50

RADIUS AND ULNA — AP View

Film — usually an 8x10 film.

Preparation — none necessary.

Posture — forearm extended resting flat on the cassette with the palmar surface of the hand up, having either one of the two extremities show on the film as a landmark. Sand bags are used to immobilize this area.

Tube position — central rays perpendicular to the cassette, directed at the area involved.

Description of the film — reveals complete contour of the extremities shown, also contour of a greater portion of the radial and ulnar shafts.

RADIUS AND ULNA — (Lateral View)

Refer to Figure No. 46, Page 219 for similar placement

Technic (With Screens)
Without Bucky

M.A.	KVP	Time	Tube D
10	55	1 sec.	36″
25	55	½ sec.	36″

With Cardboard Exposure Holder

10	55	7 sec.	36″
25	55	3 sec.	36″

Figure No. 51

RADIUS AND ULNA — (Lateral View)

Film — usually an 8x10.
Preparation — none necessary.
Posture — Patient sitting upright, forearm so placed on the cassette as to include either the upper or lower extremity, which is used as a landmark, the patient's wrist and hand rest on the cassette. Sand bags are used to immobilize this area.
Tube position — centered at area involved perpendicularly to cassette.
Description of film—Complete contour of the extremities and shafts, somewhat superimposed.

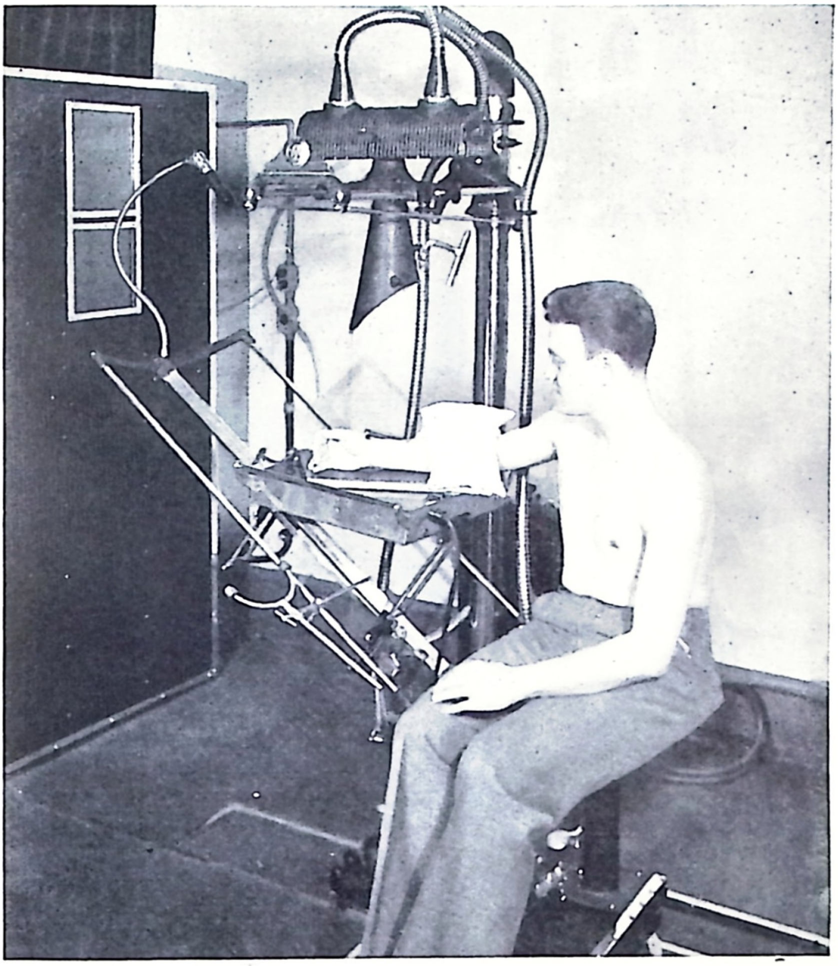


Figure No. 52

WRIST — Lateral View

Technic (With Screens)
Without Bucky

M.A.	KVP	Time	Tube D
10	50	1 sec.	36″
25	50	¼ sec.	36″

With Cardboard Exposure Holder

M.A.	KVP	Time	Tube D
10	50	7 sec.	36″
25	50	3 sec.	36″

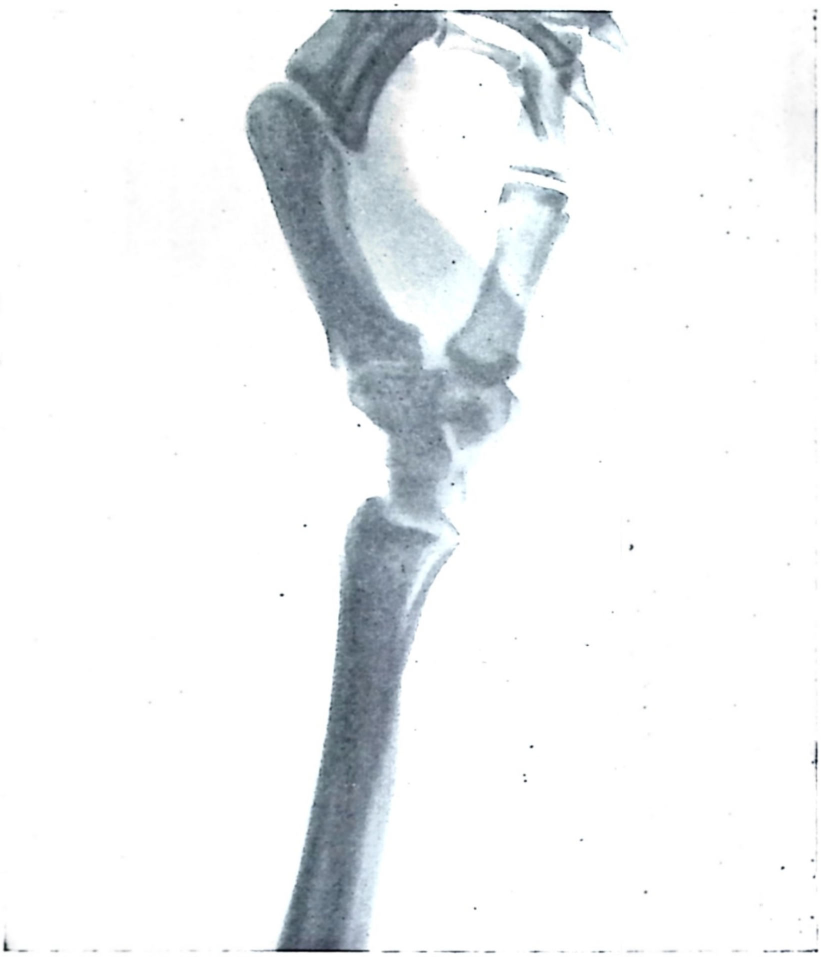


Figure No. 53

WRIST — Lateral View

Film — 8x10.

Preparation — none necessary.

Posture — The patient should be in a sitting posture with the hand on the cassette, thumb side up with the region to be X-rayed in the center of the cassette.

Tube position — center the tube directly over the wrist and have the direct rays directed at right angles to the cassette.

Description of the film — Revealing the distal end of the radius overshadowing the lower extremity of the ulna. The inferior articulating surface of the radius in its articulation with the semi-lunar and cuneiform bones. The carpals superimposed. The epiphysial separation in the distal ends of the radius and ulna in children.

WRIST — PA View

Refer to Figure No. 55, Page 231 for similar placement

Technic (With Screens)
Without Bucky

M.A.	KVP	Time	Tube D
10	50	1 sec.	36″
25	50	¼ sec.	36″

With Cardboard Exposure Holder

10	50	7 sec.	36″
25	50	3 sec.	36″

Figure No. 54

WRIST — PA View

Film — 8x10 film used.

Preparation — none necessary.

Posture — The carpal area is placed in the center of the cassette with the central rays directed over that area, patient's forearm on a level with the out-stretched hand resting on the cassette with the palmar surface of the hand down.

Tube position — Because of a tendency of the carpals to appear overshadowing one another in the view it is necessary that the rays be directed at the carpal area.

Description of the film—The shadowgraph shows the distal end and the articulating surface of the radius and its articulation with the cuneiform and semilunar, the sigmoid cavity and its articulation with the ulna; and the contour of the styloid process and its articulation with both the inferior extremity of the ulna and the sigmoid cavity of the radius by its outer surface.

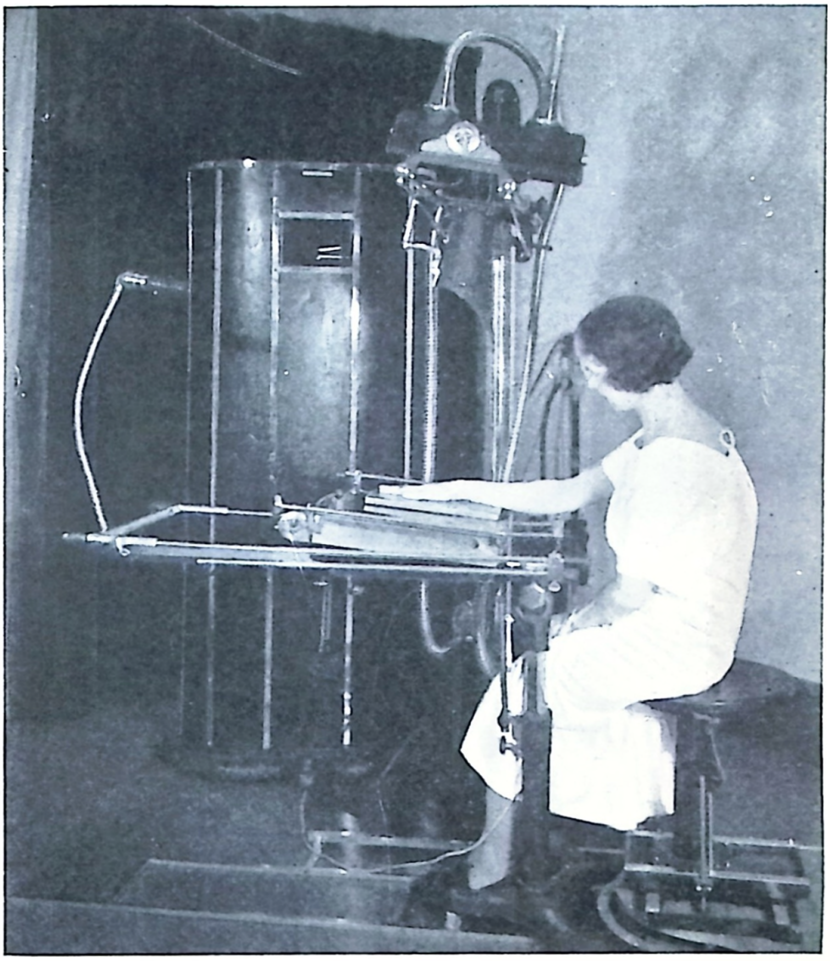


Figure No. 55

HAND — PA View

Technic (With Screens)
Without Bucky

M.A.	KVP	Time	Tube D
10	50	½ sec.	36″
25	50	2/10 sec.	36″

With Cardboard Exposure Holder

10	50	7 sec.	36″
25	50	3 sec.	36″

Figure No. 56

HAND — PA View

Film — 8x10.

Preparation — none necessary.

Posture — The palmar surface of the hand should be down, the fingers outstretched and spread slightly so that there will be less overlapping of the osseous structures, especially at the carpal end of the phalanges.

Tube position — The rays should be directed over the center of the palm.

Description of film — Complete contour of the carpals, metacarpals and phalanges, soft structure contours and articular spaces. Minute cancellous structure of metacarpal and phalangeal epiphyses. Epiphysial separations in children. Sesamoid bones in the adult.

HAND — Diagonal View

Technic (With Screens)
Without Bucky

M.A.	KVP	Time	Tube D
10	50	½ sec.	36″
25	50	2/10 sec.	36″
With Cardboard Exposure Holder			
10	50	7 sec.	36″
25	50	3 sec.	36″

Figure No. 57

HAND — Diagonal View

Film — 8x10 placed lengthwise with the hand.
Preparation — none necessary.
Posture — Patient's arm somewhat out-stretched, palmar surface of the hand down, with surface nearest little finger resting on cassette; palmar surface nearest thumb raised, tips of fingers spread and resting on the cassette.
Tube position — rays directed at the center of the hand perpendicularly to the cassette.
Description of the film—reveals phalangeal spaces and somewhat of the metacarpal and phalangeal articulations, complete contours of the phalanges, and to a certain extent, the carpals, the epiphysial separations in children and sesamoid bones in adults.

SCAPULA — AP View

Refer to Figure No. 41, Page 213 for similar placement

Technic (With Screens)

With Bucky				Without Bucky			
M.A.	KVP	Time	Tube D	M.A.	KVP	Time	Tube D
10	65	4½ sec.	36″	10	60	5 sec.	36″
25	64	1½ sec.	36″	25	60	2 sec.	36″
50	65	4/5 sec.	36″	50	60	1 sec.	36″
100	65	2/5 sec.	36″	100	60	½ sec.	36″

Figure No. 58

SCAPULA — AP View

Film — usually an 8x10 film is used.
Preparation — clothing over that area removed.
Posture — Either upright or supine, patient placed so that the shoulder appears at the outer and upper part of the film. The patient must not breathe during the exposure.
Tube position — tube placed so that rays will strike about 2 inches in from head of the humerus perpendicularly to the cassette.
Description of the film — reveals contours of its acromion process, spine of the scapula, coracoid process, glenoid fossa, and the angles and borders.

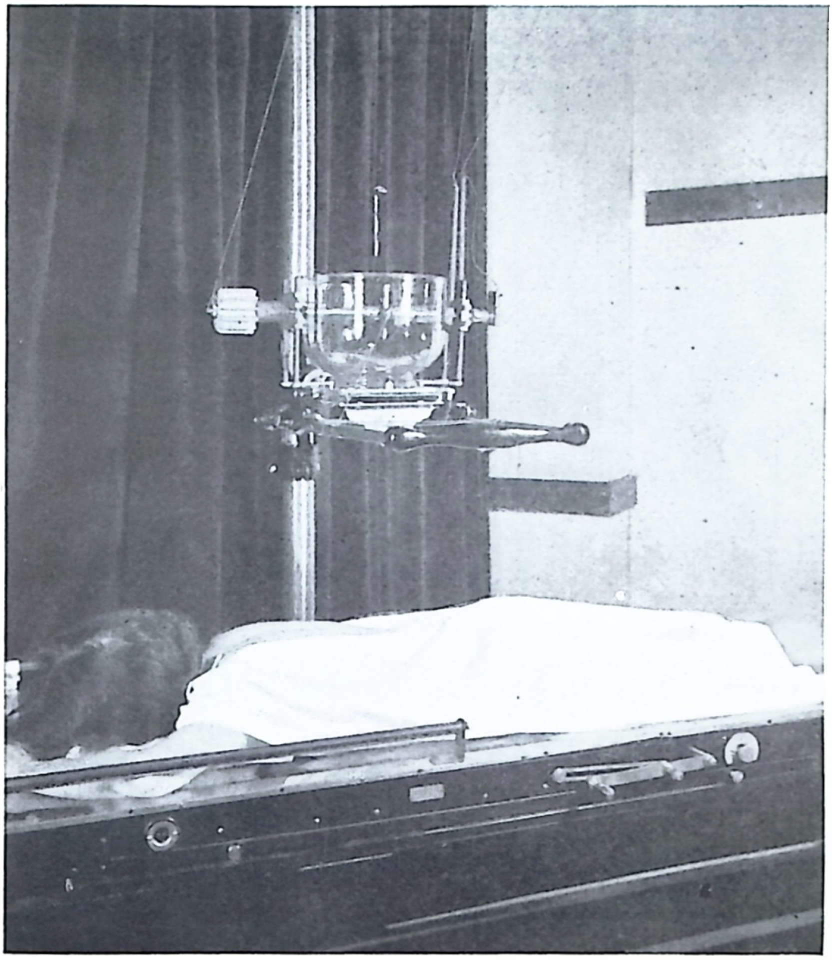


Figure No. 59

STERNUM — PA Diagonal View

Technic (With Screens)

With Bucky				Without Bucky			
M.A.	KVP	Time	Tube D	M.A.	KVP	Time	Tube D
10	60	6 sec.	30″	10	60	5 sec.	30″
25	60	2½ sec.	30″	25	60	2 sec.	30″
50	60	1-1/5 sec.	36″	50	60	1 sec.	36″
100	60	3/5 sec.	36″	100	60	½ sec.	36″

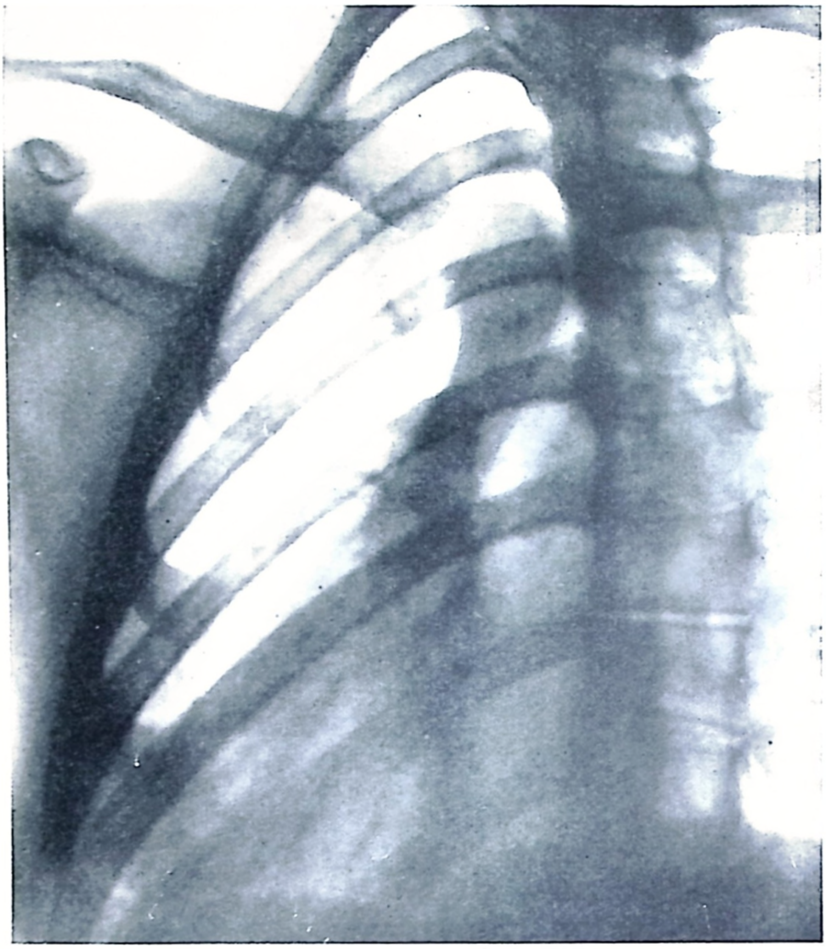


Figure No. 60

STERNUM — PA Diagonal View

Film — 8x10.

Preparation — A cotton gown is substituted for the patient's clothing.

Posture — The patient should be in either the prone or upright posture with the ventral surface of the thorax against the cassette. Place the superior edge of the film about 1¼ inch above the episternal notch.

Tube position — The tube is shifted to one side or the other of the median line of the cassette, or bucky, so that the direct rays will pass beside the spinal column to the center of the sternum.

Description of film — Complete contour of the three parts of the sternum. The articulation of manubrium or top section of sternum with clavicle. The junction of the manubrium with the body of the sternum or gladiolus and the ensiform cartilage or xyphoid process. Contours of facets for articulation with cartilage of the first seven pairs of ribs.

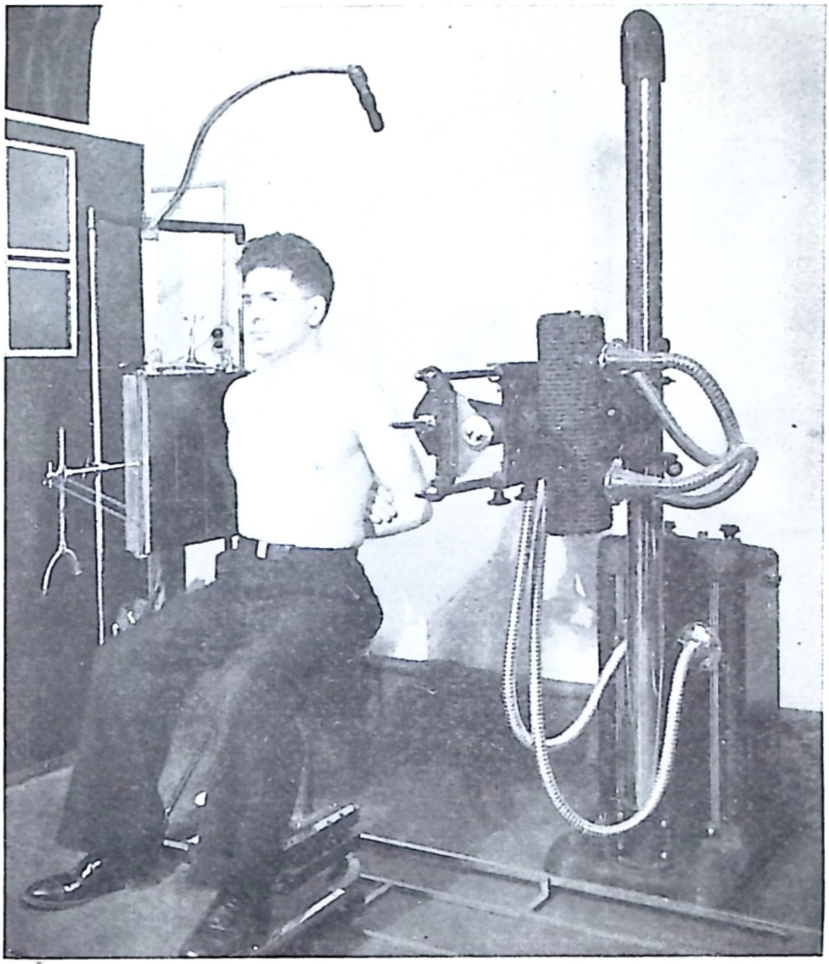


Figure No. 61

LATERAL STERNUM

Technic (With Screens)

With Bucky				Without Bucky			
M.A.	KVP	Time	Tube D	M.A.	KVP	Time	Tube D
10	65	6 sec.	30″	10	65	5 sec.	30″
25	65	2½ sec.	30″	25	65	2 sec.	30″
50	65	1¼ sec.	36″	50	65	1 sec.	36″
100	65	¾ sec.	36″	100	65	½ sec.	36″

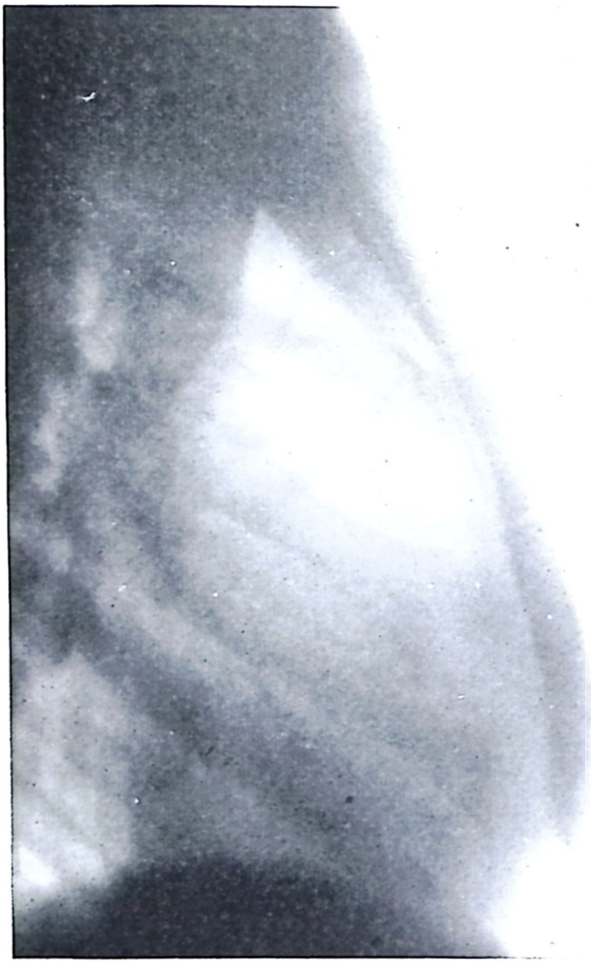


Figure No. 62

LATERAL STERNUM

Film — usually an 8x10.

Preparation — clothing over that area removed and a cotton gown substituted.

Posture — Patient's side next to the cassette with the arms forced back or extended above the head. If patient is lying on the side, compression bands are used. The top of the cassette should come about 1 inch above the episternal notch. The patient must not breathe during the exposure.

Tube position — central rays directed perpendicularly to the cassette at the mid-region of the sternum.

Description of film — Lateral view of sternum always superimposed by costal cartilages and somewhat by the chondral ends of the ribs. Revealing the three parts of the sternum, namely, the manubrium, gladiolus and ensiform cartilage.

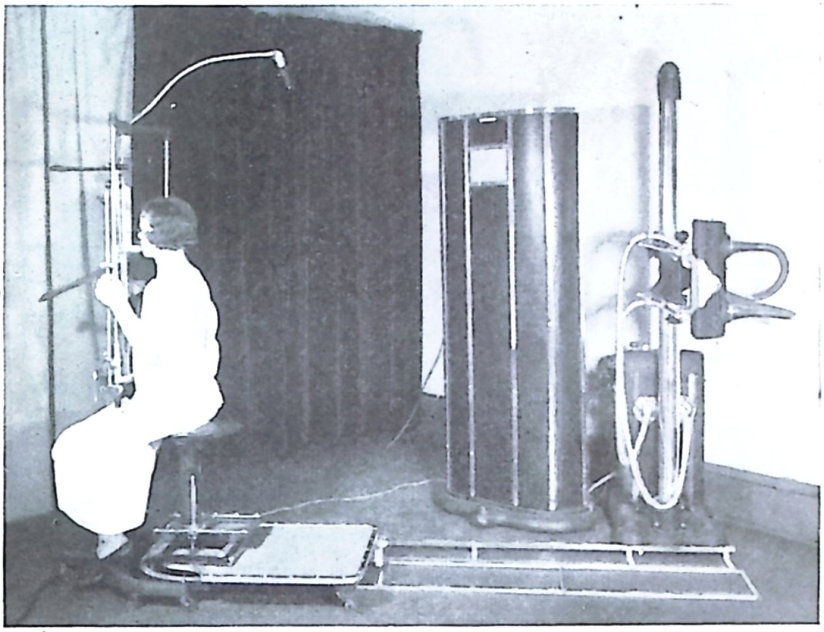


Figure No. 63

CHEST — PA View

Technic (With Screens)
Without Bucky

M.A.	KVP	Time	Tube D
50	72	¾ sec.	72″
100	67	1/5 sec.	72″
200	72	1/10 sec.	72″

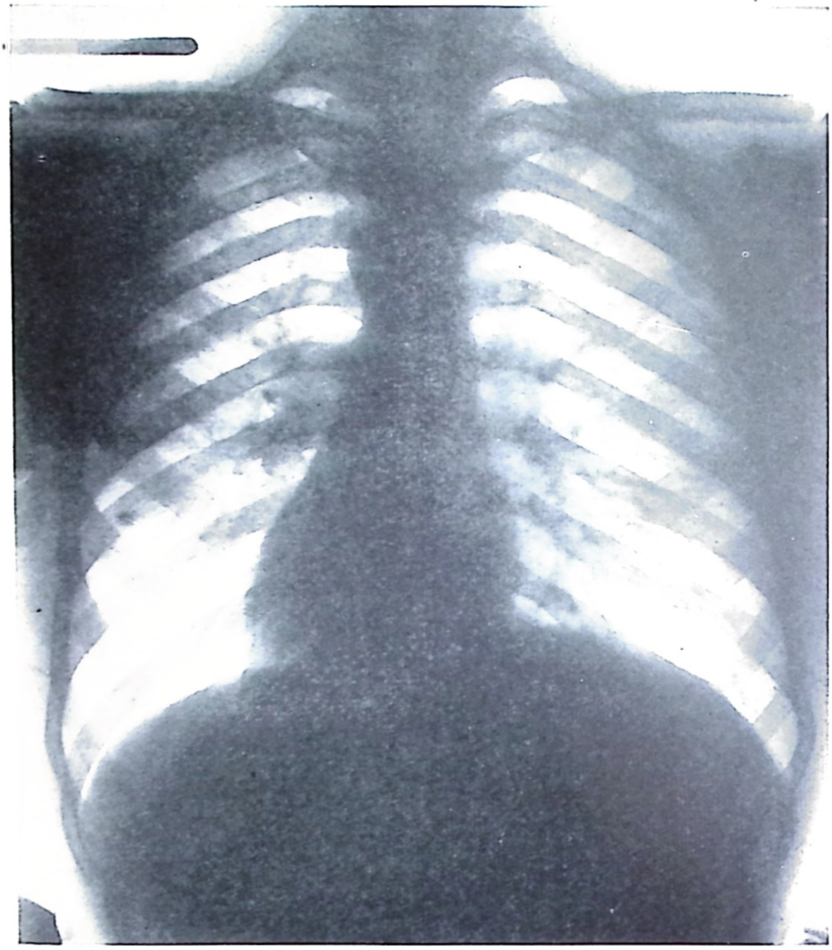


Figure No. 64

CHEST — PA View

Film — 14x17.

Preparation — cotton garment substituted for clothing.

Posture — Either sitting or standing, the patient faces the cassette, has his hands on the hips with the elbows forward, so as to pull the scapulae toward the side. The cassette is placed so that the top of the film will be even with about the fifth cervical. The patient should inhale and hold breath during the exposure.

Tube position — placed so that the central rays are directed at about the sixth dorsal, perpendicularly to the cassette.

Description of Chest — PA View — Complete contour of both lungs including the base of the lungs as well as the apices. The outline of the heart, the upper part of the diaphragm and the spine, the latter as a white shaft in a film properly made.

Contour of the hilus of the lung, the branching of the bronchi and some of the larger vessels should be seen.

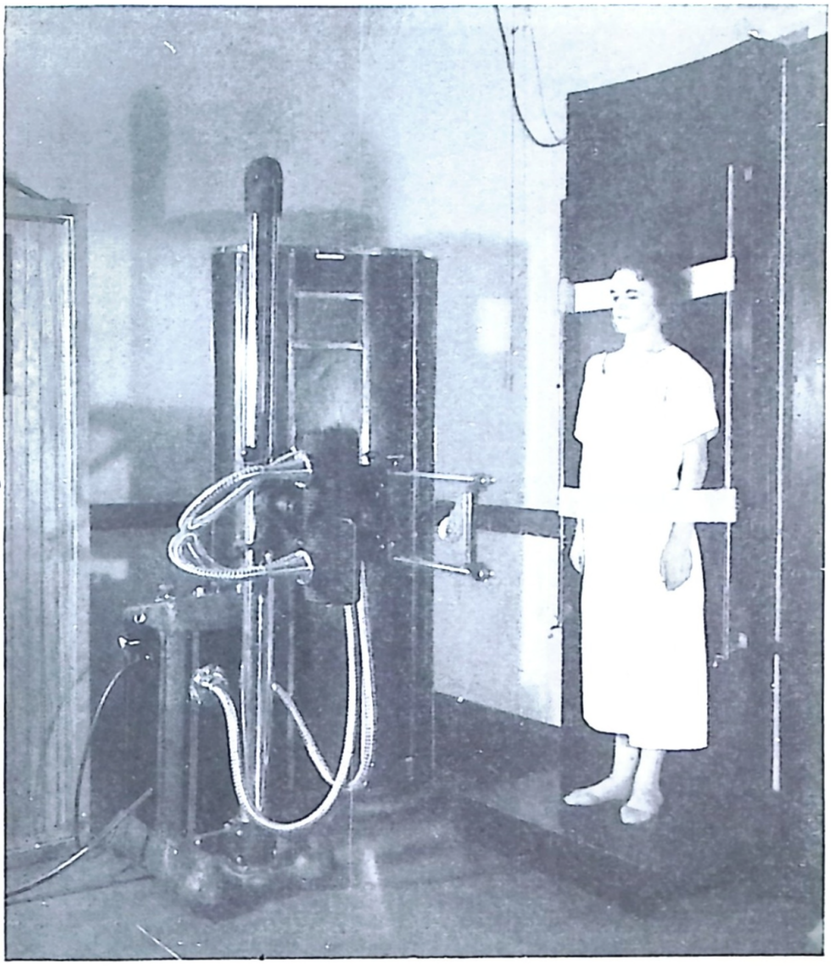


Figure No. 65

PELVIS — AP View

Technic
With Bucky

M.A.	KVP	Time	Tube D
10	80	18 sec.	48″
10	80	25 sec.	60″
25	80	8 sec.	48″
25	80	10 sec.	60″
50	80	6 sec.	72″
100	80	3 sec.	72″

Figure No. 66

PELVIS — AP View

Film — 14x17.

Preparation — clothing removed and a cotton gown substituted.

Posture — Have patient in either the supine or standing position. In the supine posture have the patient sit on the table well back so that the heels will rest on the edge of the table. Palpate the sacral hiatus. Have the patient raise the body by placing the hands on the table at his side and move the patient so that the apex of the sacrum lines up with the center of the table or cassette. Supporting the patient's weight, place the patient in a reclining posture. The heels must be of equal distance on each side of the median line of the table.

If the surgical neck of the femur is to be seen, the patient's toes should be turned in and held by means of sand bags or some other device.

The cassette is placed so that the top of the film comes about 4 inches above the superior crest of the ilium.

Tube position — Tube is placed so that the central rays are directed about three inches below the superior crest of the ilium at right angles to the cassette.

Description of Pelvis — Contour of the ilia, the sacrum, its articulation with the 5th lumbar and ilia. Contour of the ischia and pubic arches, the space separating the pubic arches, partial contour of the obturator foramina, the sciatic notches, the acetabuli, the head of the femur articulating in the above. Often the surgical necks and the greater and lesser trochanters are seen.

FEMUR

Technic (With Screens)

With Bucky				Without Bucky			
M.A.	KVP	Time	Tube D	M.A.	KVP	Time	Tube D
10	72	7 sec.	36″	10	66	5 sec.	36″
25	70	3 sec.	36″	25	66	2 sec.	36″
50	70	1½ sec.	36″	50	66	1 sec.	36″
100	70	¾ sec.	36″	100	66	½ sec.	36″

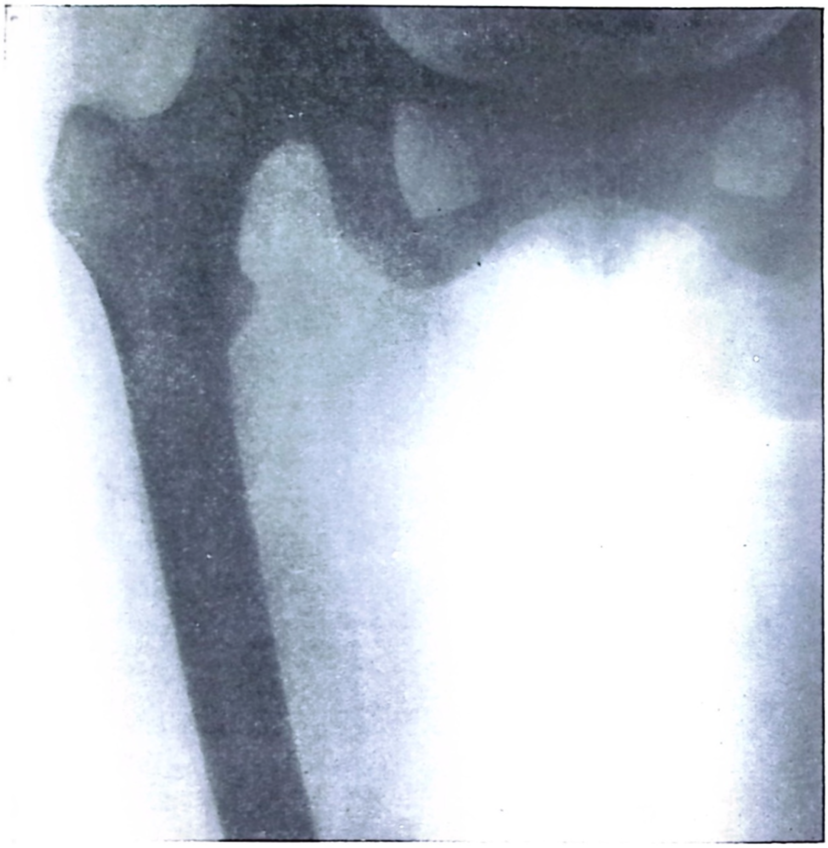


Figure No. 67

FEMUR

Film — preferably a 14x17.
Preparation — clothing removed from this area.
Posture — Patient should be placed in either the standing or supine posture. The cassette should be placed so as to include one extremity as a land mark. If the head of the femur, surgical neck, trochanters and upper shaft are to be X-rayed the toes should be turned in, this rotates the great trochanter externally and allows for an unobstructed view of the descriptive parts mentioned above.
Tube position — Rays should be directed perpendicularly to the cassette.
Description of the film — Contour of the head of the humerus, reveals the epiphysial lines, the great trochanter, lesser trochanter, surgical neck, the upper portion of the shaft and the epiphysial separations in children. The lower extremity with the shaft shows contours of condyles, intercondyloid fossa, epiphysial separations in children and contour of the shaft.

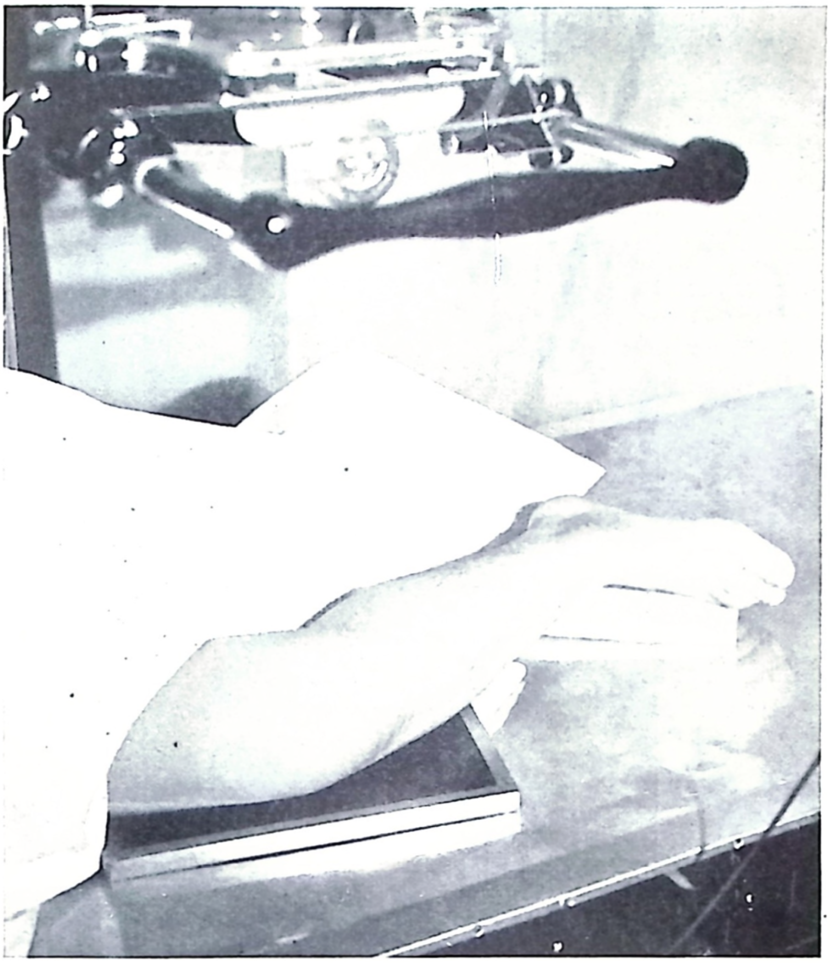


Figure No. 68

KNEE — Lateral View

Technic (With Screens)
Without Bucky

M.A.	KVP	Time	Tube D
10	55	2 sec.	36″
25	55	¾ sec.	36″

With Cardboard Exposure Holder

M.A.	KVP	Time	Tube D
10	55	7 sec.	36″
25	55	3 sec.	36″

Figure No. 69

KNEE — Lateral View

Film — 8x10.

Preparation — Clothing should be removed from this area.

Posture — The patient should be reclining on his side with the knee to be X-rayed nearest the table. The cassette is placed so as to show the knee in the center of the film. Use sand bags to immobilize.

Tube position — Tube is placed so as to direct the central rays at the knee perpendicularly to the cassette.

Description of the film — Shows contours of the lower extremity of the femur; its articulation with the tibia; the superior extremity of the tibia and fibula; and the patella.

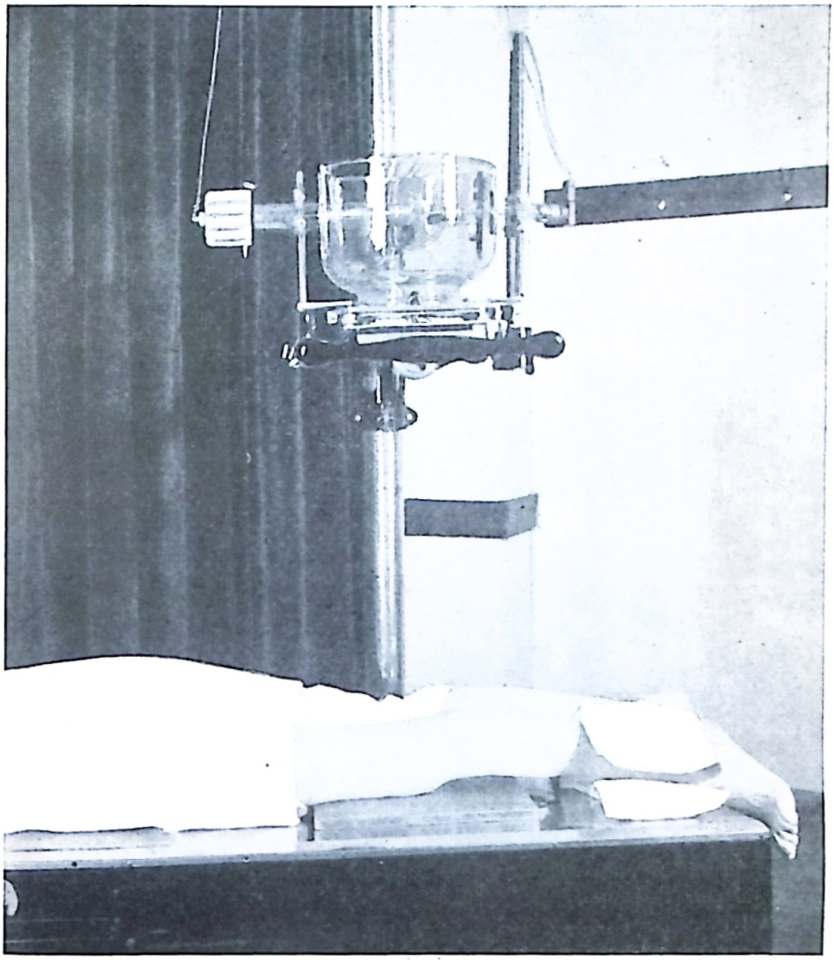


Figure No. 70

KNEE — PA View

Technic (With Screens)
Without Bucky

M.A.	KVP	Time	Tube D
10	60	2 sec.	36″
25	60	¾ sec.	36″

With Cardboard Exposure Holder

10	60	7 sec.	36″
25	60	3 sec.	36″

Figure No. 71

KNEE — PA View

Film — 8x10.

Preparation — Remove clothing from the area to be X-rayed.

Posture — The patient is in a supine position with the knee to be X-rayed in the center of the cassette. Immobilize the area with sand bags.

Tube position — Rays are directed at the knee, perpendicularly to the cassette.

Description of the film — Shows complete contour of the inferior extremity of the femur, and its articulation with the tibia; the superior extremity of the tibia and fibula, and the outline of the patella, superimposed upon the lower extremity of the femur. The epiphysial lines in the adult and the epiphysial separations in the children are shown.

KNEE — AP View

Refer to Figure No. 70, Page 249 for reverse placement

Technic (With Screens)
Without Bucky

M.A.	KVP	Time	Tube D
10	60	2 sec.	36″
25	60	¾ sec.	36″

With Cardboard Exposure Holder

10	60	7 sec.	36″
25	60	3 sec.	36″

Figure No. 72

KNEE — AP View

Film — 8x10.

Preparation — Remove clothing from the area to be X-rayed.

Posture — The patient is in the supine posture with the knee to be X-rayed in the center of the film. Immobilize this area with sand bags.

Tube position — rays are directed at the knee perpendicularly to the cassette.

Description of the film — Shows complete contours of the inferior extremity of the femur and its articulation with the tibia, the superior extremity of the tibia and fibula and the outline of the patella, superimposed upon the lower extremity of the femur; the epiphysial lines in the adult; and the epiphysial separations in the child.

AP TIBIA AND FIBULA

Technic (With Screens)
Without Bucky

M.A.	KVP	Time	Tube D
10	55	2 sec.	36″
25	55	¾ sec.	36″

With Cardboard Exposure Holder

M.A.	KVP	Time	Tube D
10	55	7 sec.	36″
25	55	3 sec.	36″

Figure No. 73

AP TIBIA AND FIBULA

Film — 8x10.

Preparation — Remove clothing from area to be X-rayed.

Posture — Patient is in either the supine or prone position, cassette placed so as to reveal either the upper or lower extremity as a landmark. The patient's leg is outstretched with heel resting on table or some support, toes extending upward. Sand bags are used to immobilize this area.

Tube position—central rays directed perpendicularly to the cassette.

Description of the film—Shows complete contour of the extremities and a greater portion of the tibial and fibular shafts.

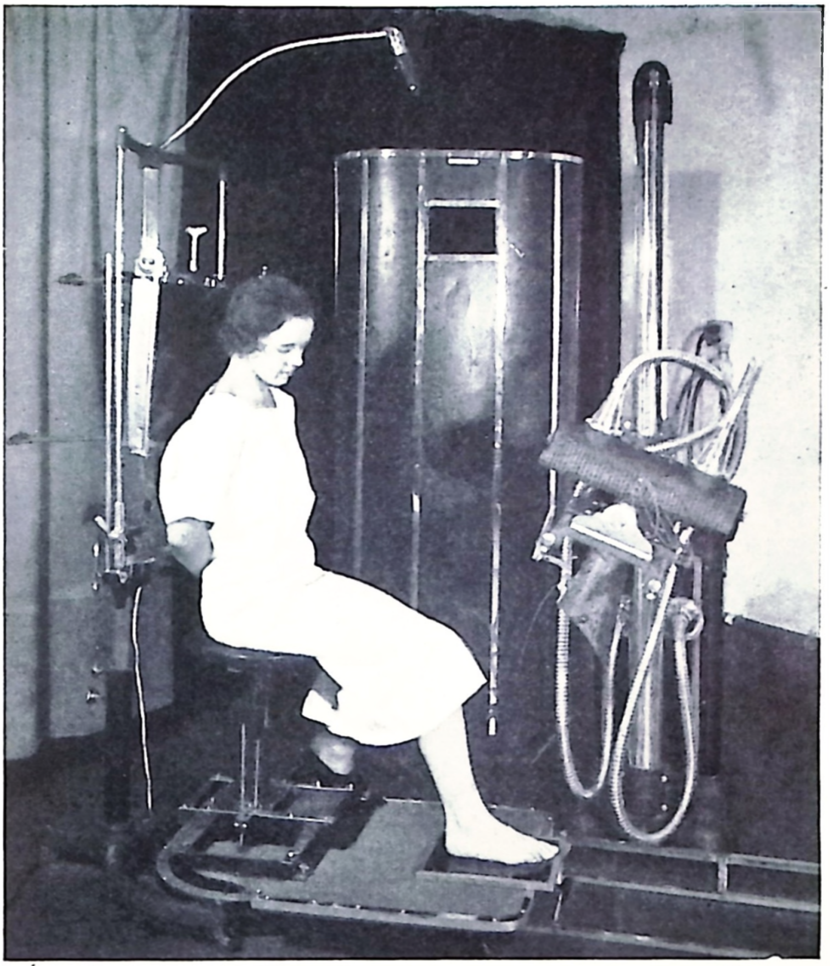


Figure No. 74

FOOT — AP View

Technic (With Screens)
Without Bucky

M.A.	KVP	Time	Tube D
10	50	2 sec.	36″
25	50	¾ sec.	36″

With Cardboard Exposure Holder

10	50	7 sec.	36″
25	50	3 sec.	36″

Figure No. 75

FOOT — AP View

Film — 8x10.

Preparation — clothing removed from this area.

Posture—The patient can be in either a sitting or standing position. If standing, the foot to be X-rayed is extended forward and rests flat on the cassette. If sitting, the foot is extended forward and likewise rests flat on the cassette.

Tube position — The rays are directed to about the center of the foot at right angles to the contour of the top of the foot.

Description of the film — It is practically impossible to get any definite and distinct view of the os calcis from this position because there is a difference in the density and thickness between it and the phalangeal end of the foot.

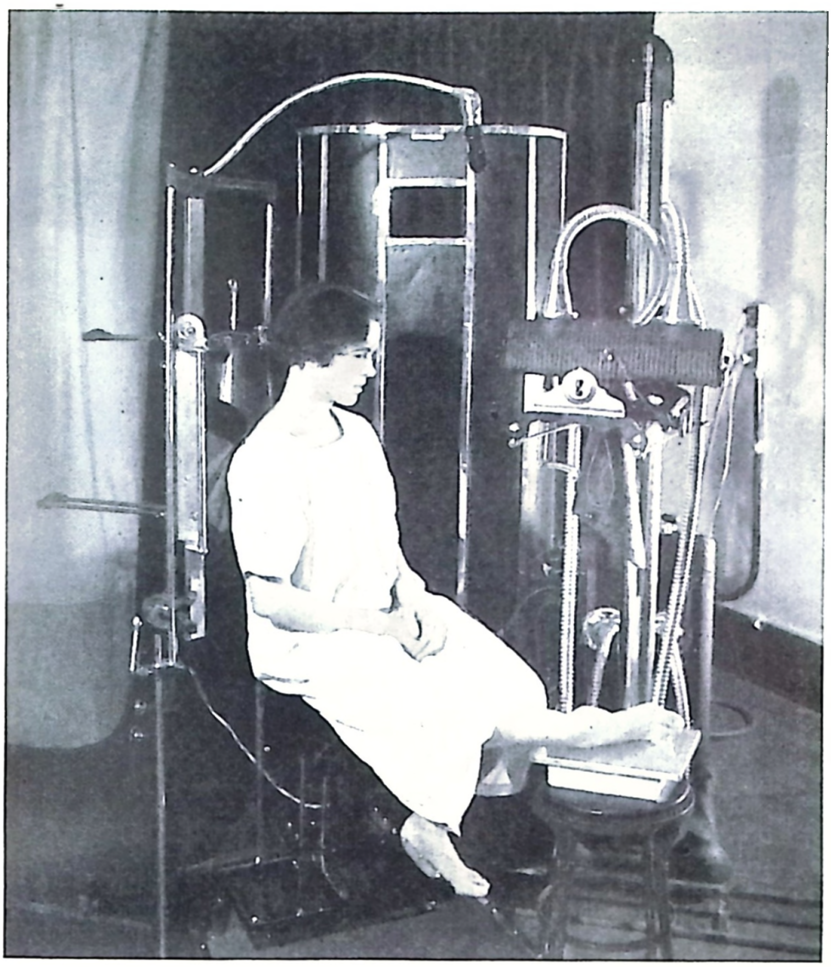


Figure No. 76

ANKLE — Lateral View

Technic (With Screens)
Without Bucky

M.A.	KVP	Time	Tube D
10	50	2 sec.	36″
25	50	¾ sec.	36″

With Cardboard Exposure Holder

10	50	7 sec.	36″
25	50	3 sec.	36″

Figure No. 77

ANKLE — Lateral View

Film — 8x10.

Preparation — Remove clothing from the area to be X-rayed.

Posture — The patient should be in either a sitting or reclining posture. The external side of the foot is flat on the cassette with the ankle in the center of the film. Sand bags are used to immobilize this area.

Tube position — The tube should be placed so that the central rays are directed at the ankle and perpendicularly to the cassette.

Description of the film — Reveals the contour of the lower extremity of the tibia and fibula, the tarsals and their articular surfaces and spaces.

LATERAL FOOT

Refer to Figure No. 76, Page 257 for similar placement

Technic (With Screens)
Without Bucky

M.A.	KVP	Time	Tube D
10	55	2 sec.	36″
25	55	¾ sec.	36″

With Cardboard Exposure Holder

M.A.	KVP	Time	Tube D
10	55	7 sec.	36″
25	55	3 sec.	36″

Figure No. 78

LATERAL FOOT

Film — 8x10.

Preparation — Remove clothing from area to be X-rayed.

Posture — Place patient in either a sitting or reclining posture with external side of foot flat on cassette. Sand bags should be used to immobilize this area.

Tube position — Placed so that the central rays are perpendicular to the cassette.

Description of the film — revealing the contour of the lower extremity of the tibia and fibula, the tarsals and their articular surfaces and spaces, and somewhat of the metatarsals and phalanges.

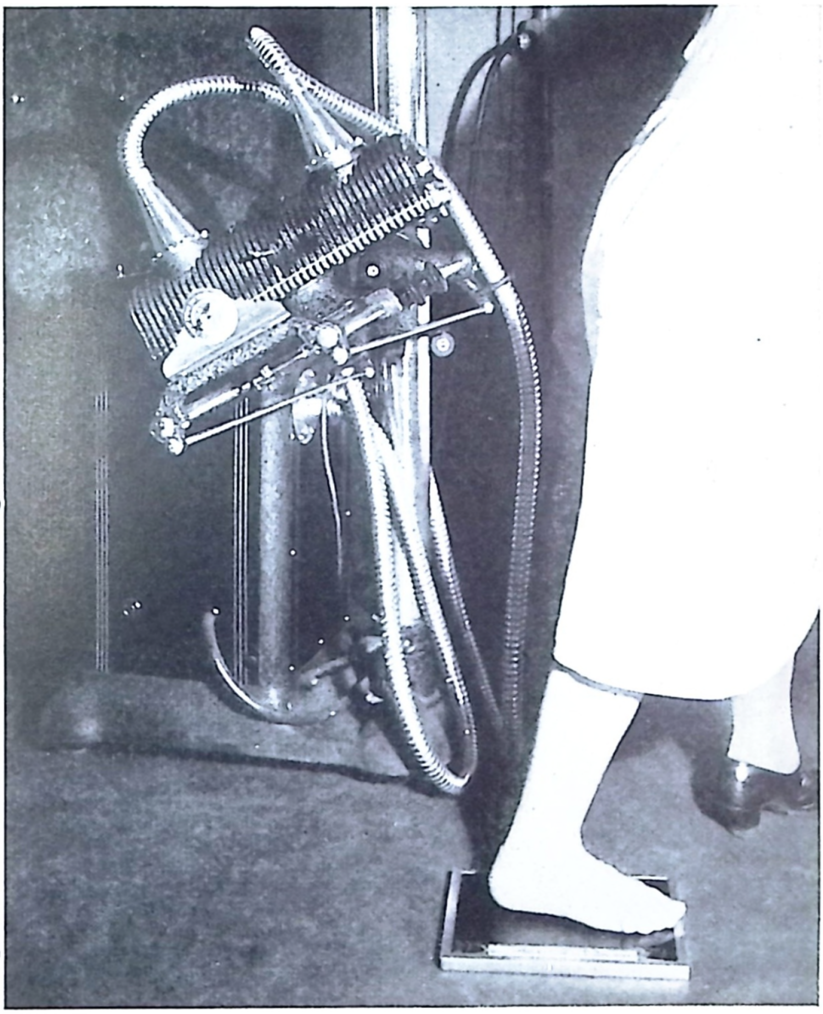


Figure No. 79

OS CALCIS

Technic (With Screens)
Without Bucky

M.A.	KVP	Time	Tube D
10	55	2 sec.	36″
25	55	¾ sec.	36″
With Cardboard Exposure Holder			
10	55	7 sec.	36″
25	55	3 sec.	36″

Figure No. 80

OS CALCIS

Film — 8x10, lengthwise of foot.
Preparation — remove clothing from this area.
Placement—Patient should either be standing with the foot to be X-rayed back, or he should be lying in a prone position with his toes on table. Film should be placed firmly against the plantar surface of the foot, and held firmly by sand bags or angle board.
Tube position — Rays are directed at the heel at about a 45 degree angle with the cassette.
Description of the film — Reveals contour of posterior and lateral margins of os calcis, the epiphysial lines in adults and the epiphysial separations in children.

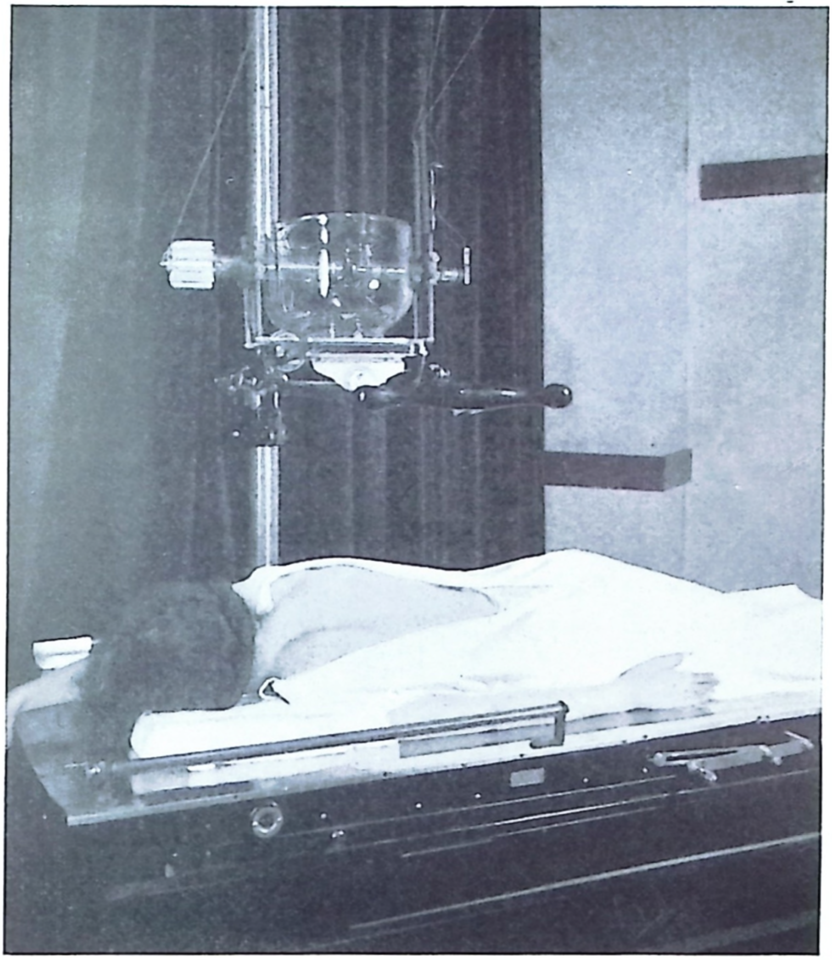


Figure No. 81

STOMACH — Prone

Technic
With Bucky

M.A.	KVP	Time	Tube D
10	68	10 sec.	30″
25	65	4 sec.	30″
50	68	2 sec.	30″
100	68	1 sec.	30″

Figure No. 82

STOMACH — Prone — PA View

Film — 14x17.
Preparation — Refer to Page 263.

Placement — The patient should be in a prone position in the vertical center of the table with his hands and arms at the sides or above the head. The face is turned to one side. If a previous examination has not been made in locating the position of the stomach then the cassette should be placed so that the center will be about 2 inches above the umbilicus. The patient should not breathe during the exposure.

Tube position — The tube is placed so that the central rays are directed at the vertical and horizontal center of the cassette.

Description of film — Barium area contours. Sufficient contours of soft and bony structures to facilitate locating stomach anatomically.

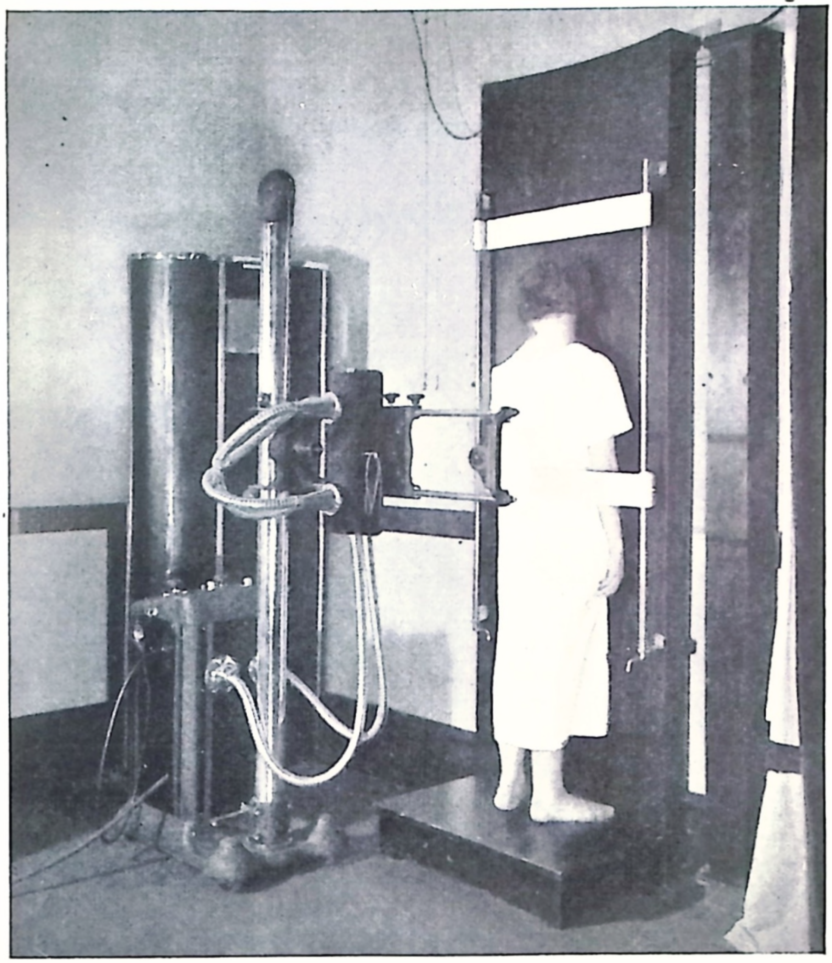


Figure No. 83

STOMACH — PA View

Technic
With Bucky

M.A.	KVP	Time	Tube D
10	68	10 sec.	30″
25	65	4 sec.	30″
50	68	2 sec.	30″
100	68	1 sec.	30″

STOMACH — Standing — PA View

Refer to Figure No. 83, Page 265

Film — 14x17.

Preparation — Instructions for Gastro-Intestinal Examination.

Ladies are requested to remove the clothing and put on a light weight laboratory gown. They are permitted to bring their own kimono, providing it is not silk and there are no buttons or metallic fasteners, to be worn for the entire examination. Men are requested to drop the clothing to the waist line.

It is important that the following directions or instructions be followed accurately and that the patient should not fail to return for final examination.

No. 1 — Though cathartics and enemas are sometimes given on the night before the examination, perhaps better results may be obtained if such procedures were not followed nor any given during the examination.

No. 2 — On the morning of the examination omit the breakfast, give the entire X-ray powder prescribed (two ounces of barium-sulphate), mix it thoroughly with four teaspoons full of well cooked wheat cereal or oat meal, add sugar and milk, not cream, to suit your taste; or the barium malted milk mixture with six to eight teaspoons well mixed in two glasses of water. Of course, a larger quantity may be used if denser shadows are desired. The latter may be obtained in five pound cans or more. However, this meal should be taken in the A.M. shortly before the examination. At this time the patient may take any amount of water that he likes. After this breakfast they should take no food or drink whatever, not even water, and again report at the X-ray department for the second exposure at a specified time later in the day, usually 5 to 6 hours lapse between first two exposures.

No. 3 — After the first examination is completed they may eat and drink as they like but take no cathartics or enemas until the final examination has been completed.

No. 4 — Patient should return to the X-ray department at the time specified the following day for the final examination.

Placement — The patient should be standing, facing the upright table, with arms placed at the side or over the head. The head should be turned to the side; use compression bands to immobilize. The cassette is placed with its center about 2 inches above the umbilicus.

Tube position — Direct the central rays perpendicularly to the horizontal and the vertical center of the cassette.

Description of film — Same as Stomach — Prone — PA View.

STOMACH and Colon

Refer to Figure Nos. 81 and 83, Pages 263 and 265 for similar placements

Technic
With Bucky

M.A.	KVP	Time	Tube D
10	68	10 sec.	30″
25	65	4 sec.	30″
50	68	2 sec.	30″
100	68	1 sec.	30″

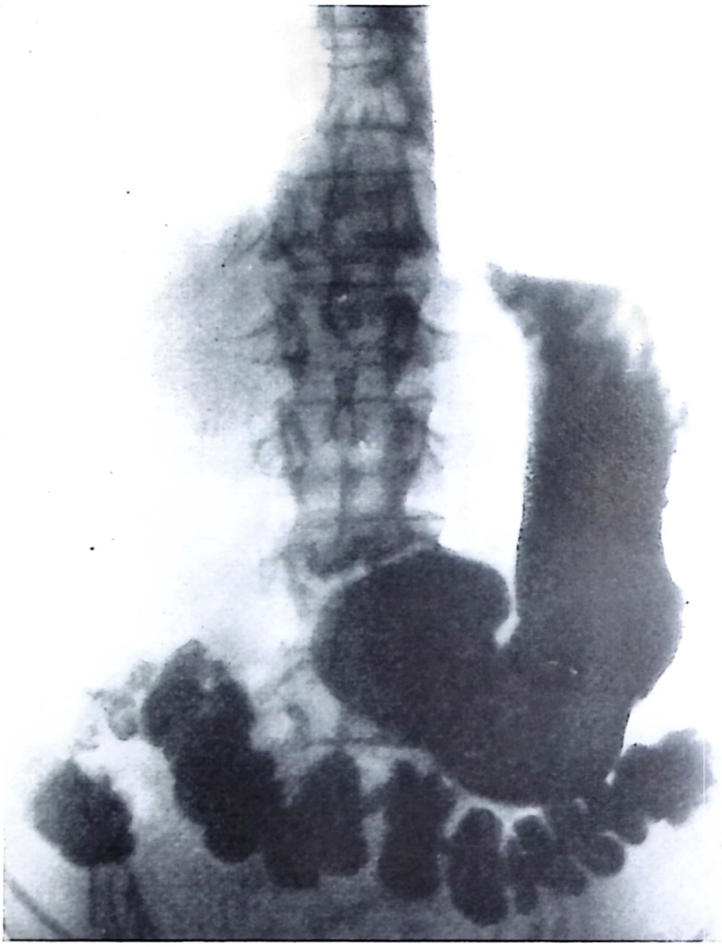


Figure No. 84

STOMACH and COLON — PA View

Radiographing stomach and colon using barium meal, given at such times as is necessary to reveal the barium meal in the stomach and in the colon at the same time. Showing relative positions of stomach and transverse colon.

COLON — PA View

Refer to Figures Nos. 81 and 83, Pages 263 and 265

Technic
With Bucky

M.A.	KVP	Time	Tube D
10	68	10 sec.	30″
25	65	4 sec.	30″
50	68	2 sec.	30″
100	68	1 sec.	30″

Figure No. 85

COLON — PA View

Film — 14x17.

Preparation — Refer to Page 266.

Posture — Placement of the patient is the same as used for the X-ray picture of the stomach. The cassette is placed so that its center will be directly in front of and under the umbilicus. The patient should not breathe during the exposure.

Tube position — The central rays are perpendicular to the horizontal and vertical center of the cassette.

Description of film — Barium area contours. Sufficient contours of soft and bony structures to enable making relative anatomical location of barium areas.

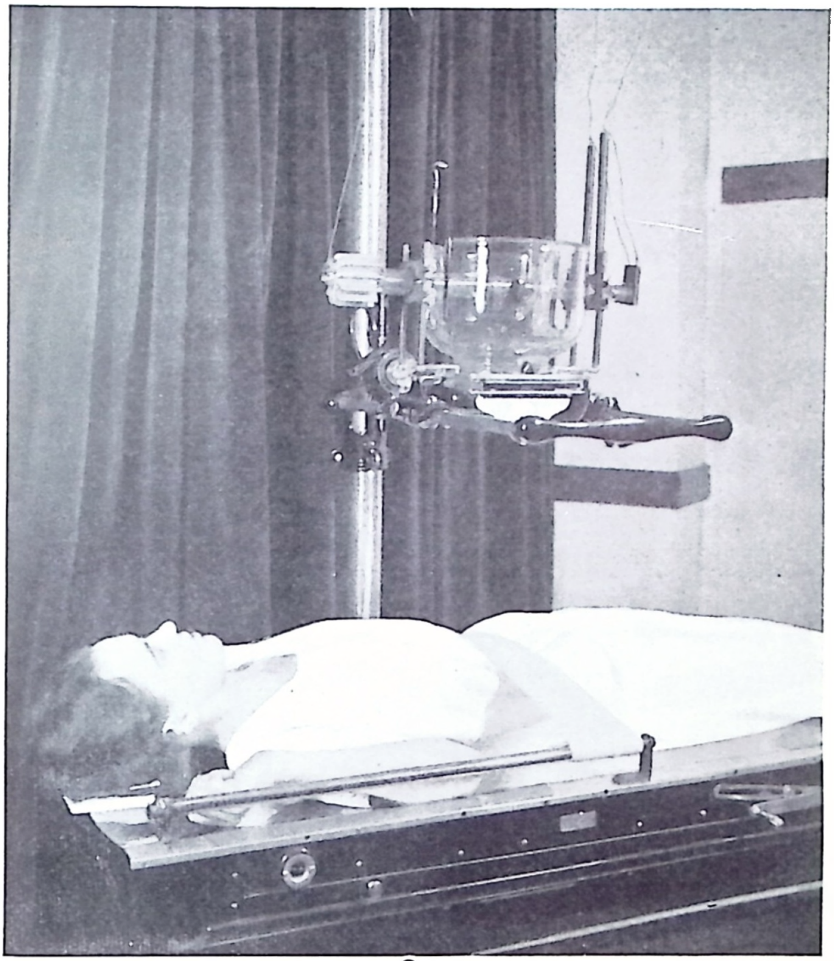


Figure No. 86

KIDNEY — AP View

Technic
With Bucky

M.A.	KVP	Time	Tube D
10	70	10 sec.	36″
25	68	4 sec.	36″
50	70	2 sec.	36″
100	70	1 sec.	36″

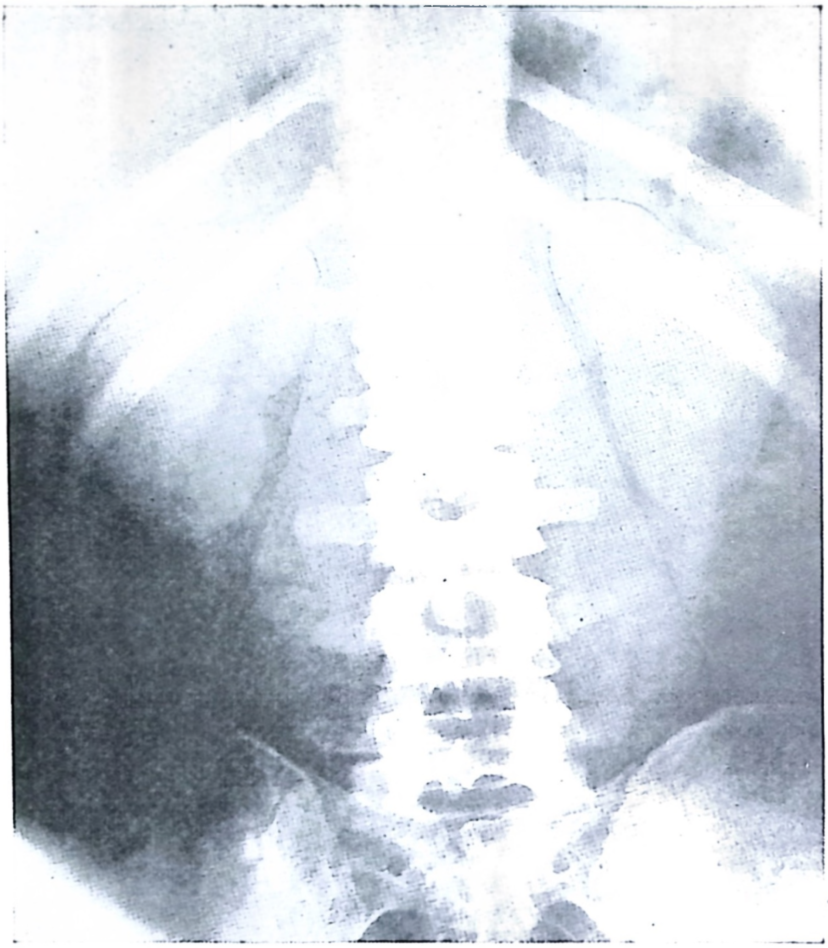


Figure No. 87

KIDNEY — AP View

Film — 14x17.

Preparation — A cotton gown is substituted for the patient's clothing.

Placement — The patient should be in the supine posture in the center of the table. The kidney area is compressed by means of a wide compression band. The cassette is placed with its inferior edge about 4 inches below the superior crest of the ilium.

Tube position—This should be at right angles to the cassette center.

Description of film — Complete contour of lumbar vertebrae, base of sacrum and superior crest of the ilia, all more or less distinct. Psoas muscle lines showing laterally to lumbar vertebrae. Partial or complete contour of kidneys.

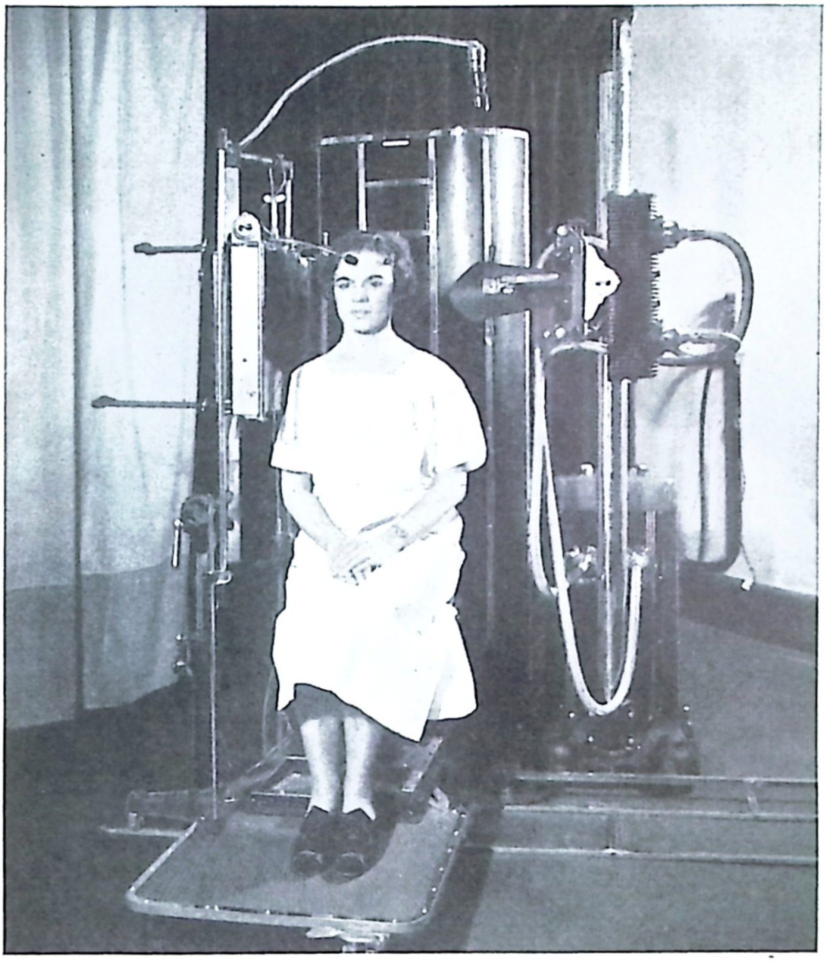


Figure No. 88

LATERAL CERVICAL

Technic (With Screens)

With Bucky				Without Bucky			
M.A.	KVP	Time	Tube D	M.A.	KVP	Time	Tube D
10	65	5 sec.	30″	10	55	3 sec.	30″
25	65	2 sec.	30″	25	55	1¼ sec.	30″
50	65	1 sec.	30″	50	55	¾ sec.	30″
100	65	½ sec.	30″				

Figure No. 89

LATERAL CERVICAL

Film — 8x10.

Preparation — Remove clothing from the area to be X-rayed.

Posture — The patient, sitting upright is placed so that his face is parallel with the plane line of the cassette—with the external auditory meatus in the vertical center of the cassette. The cassette is so placed that the superior edge of the film comes about even with the superior edge of the pinna of the ear.

Tube position — Placed parallel with the cassette or bucky diaphragm so that the central rays are directed at the meatus of the ear, at right angles to the cassette or bucky.

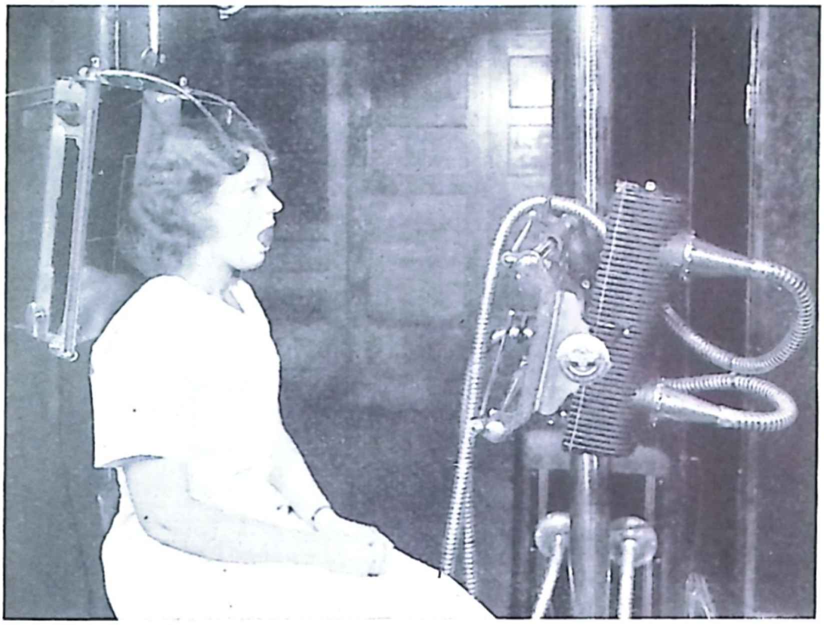


Figure No. 90

AP CERVICAL

Technic
With Bucky Diaphragm

M.A.	KVP	Time	Tube D
10	75	8 sec.	30″
25	76-80	3 sec.	30″
50	75	1½ sec.	30″
100	75	¾ sec.	30″

Without bucky diaphragm Technic same as above with the exception the KVP is cut approximately ten points. It may be advisable instead of cutting KVP ten points to only cut about five and cut the time.

Figure No. 91

AP CERVICAL

Film — 8x10.

Preparation — Upright sitting—clothing over area removed. Supine placement—Cotton gown substituted for clothing.

Posture — Patient sitting upright or in supine posture, is placed so that the external occipital protuberance appears in the vertical center of cassette and the A to P center of head is at right angles to film or cassette. The cassette is so placed that the superior edge of the film comes about two inches below the top of the head.

Tube Position — With few exceptions the tube is placed parallel with the cassette or bucky diaphragm so that the central rays are directed at the base of the occiput when bisecting the open mouth.

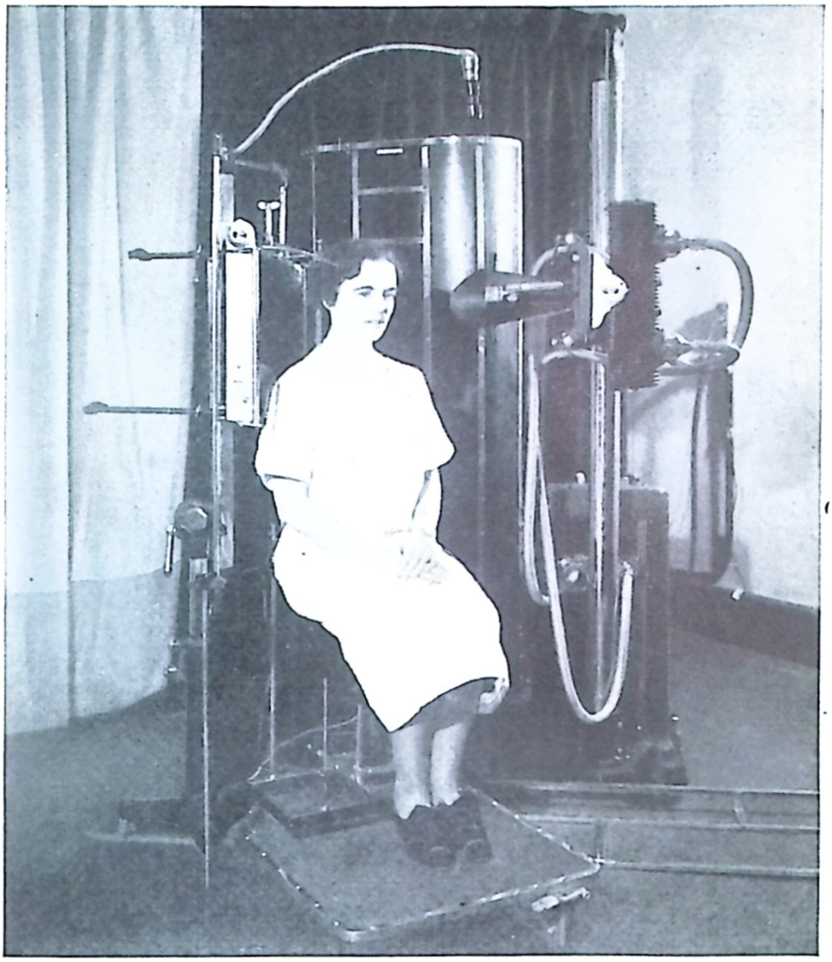


Figure No. 92

DIAGONAL CERVICALS

Technic (With Screens)

With Bucky				Without Bucky			
M.A.	KVP	Time	Tube D	M.A.	KVP	Time	Tube D
10	60	5 sec.	30″	10	55	5 sec.	30″
25	60	2 sec.	30″	25	55	2 sec.	30″
50	60	1 sec.	30″	50	55	1 sec.	30″
100	60	½ sec.	30″	100	55	½ sec.	30″

Figure No. 93

DIAGONAL CERVICALS

Film — 8x10.

Preparation — Cotton gown substituted for patient's clothing.

Posture — The patient sitting upright is rotated about 35 degrees towards the tube from a true lateral position. The Atlas and Axis should be in the median line, vertically.

Tube position — The central rays are directed on a level with the meatus of the ear.

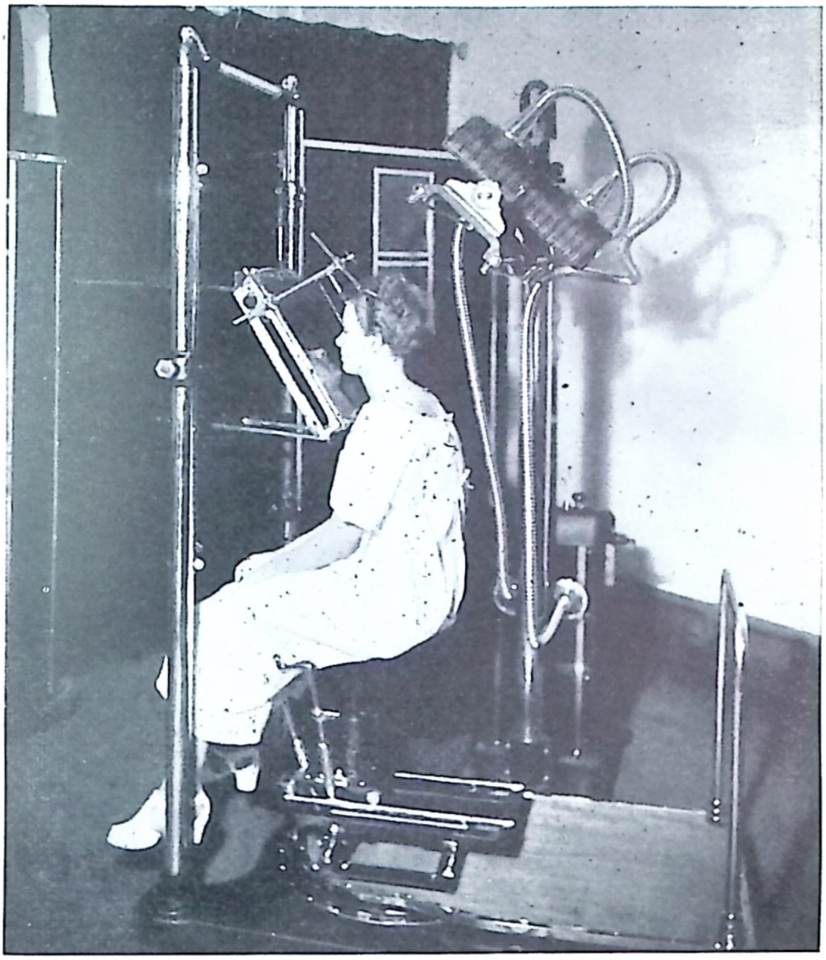


Figure No. 94

VERTEX STEREO.

Technic
With Bucky

MA	KVP	Time	Distance Tube	Separation Tube
15	76-80	10 sec.	30″	2½″
25	76-80	6 sec.	30″	2½″
100	76-80	1½ sec.	30″	2½″

Figure No. 95

VERTEX STEREO.

Film — 8x10.

Preparation — Hair pins, dentures, etc., removed.

Posture — The patient should be sitting upright facing the cassette or bucky diaphragm. The head is tilted slightly backward. Any lateral tilt is removed by the patient flexing below the shoulders. Rotation of the head is removed by rotating the body. The cassette or bucky is so placed that the chin will appear about on the upper two-thirds of the film. The patient is placed in the center of the cassette by visual observation, touching the cassette at both the lower and upper extremity.

Tube position — The central rays directed so that they will bisect the tip of the mastoid striking a point on the cassette about 2 or 2½″ below the point of the chin.

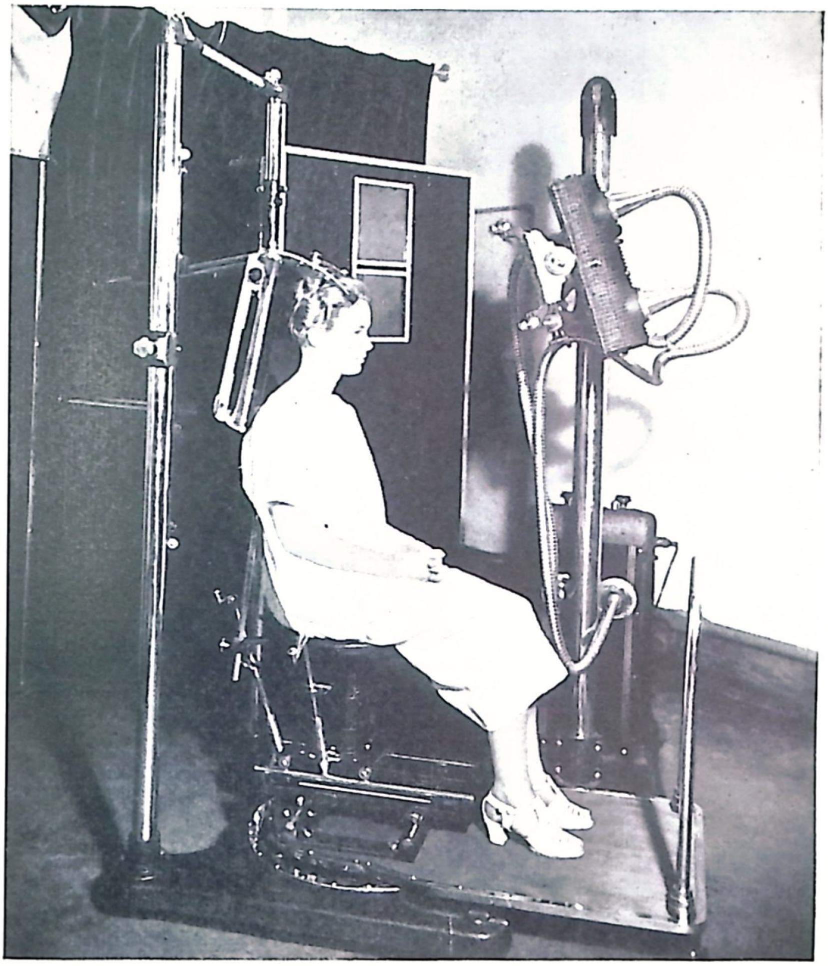


Figure No. 96

NASIUM — AP View

Technic (With Screens)

With Bucky				Without Bucky			
M.A.	KVP	Time	Tube D	M.A.	KVP	Time	Tube D
10	70	8-10	30″	10	60	6-8 sec.	30″
25	72	3 sec.	30″	25	62	2½ sec.	30″
50	72	6 sec.	60″	50	60	6 sec.	60″
100	75	3 sec.	60″	100	60	3 sec.	60″

NASIUM — AP View

Film — 8x10 film is to be used.

Preparation — Hairpins, dentures, etc. removed.

Placement — Either supine or upright sitting posture same as AP cervical views, except the mouth is kept closed.

Tube Position — Tube is so placed as to direct central rays at the base of the occiput, through the base of the nose.

Description of film — Atlas appears superior to upper teeth on film, viewed through nasal septum. Should be able to see condyles, jugular processes, anterior foramen magnum area and odontoid process of axis.

DORSAL — AP View

Refer to Figure Nos. 105 and 108, Pages 295 and 298 for similar placements

Technic
With Bucky

M.A.	KVP	Time	Tube D
10	70	8 sec.	30″
25	70	3½ sec.	30″
50	70	2 sec.	36″
100	70	1 sec.	36″

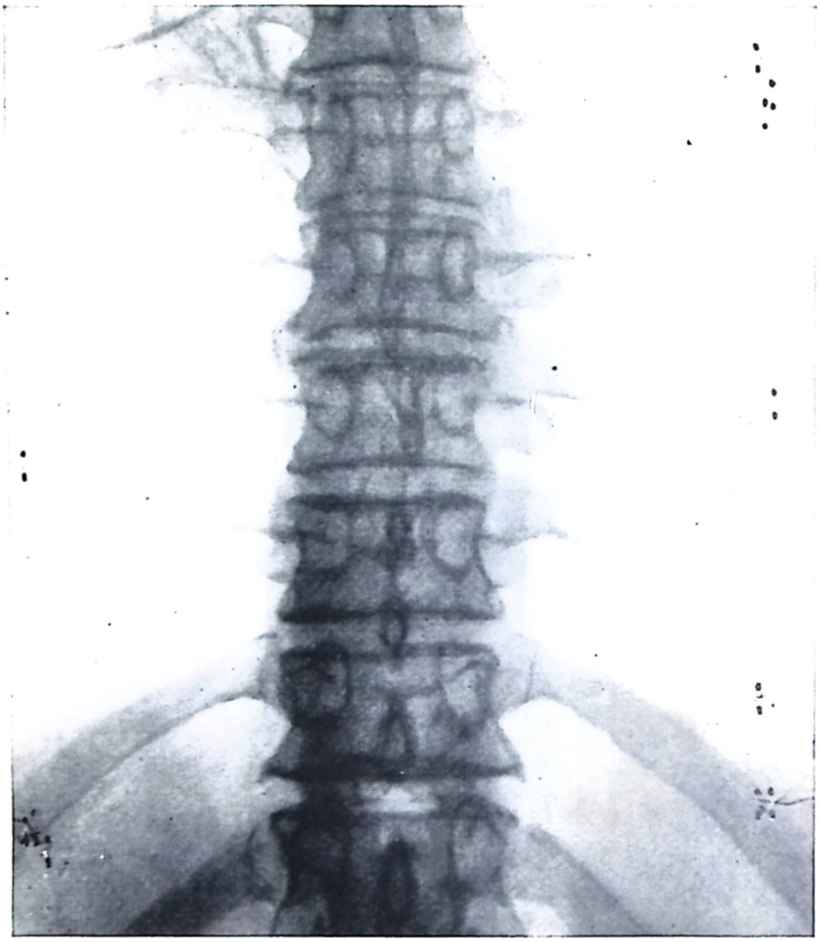


Figure No. 97

DORSAL — AP View

Film — 8x10 or 14x17.

Preparation — Cotton gown substituted for the patient's clothing.

Placement — Supine or upright, patient is placed on the table, lining the sacral hiatus and the external occipital protuberance with the center of the table in much the same manner as for the full spine work (supine posture). Compression band is not necessary. For upright sitting or standing, line the patient up by visual observation. If using an 8x10 film the cassette is placed so as to include either the 1st dorsal or the 12th dorsal as a landmark.

Tube position — The central rays should be directed perpendicularly to the center of the cassette.

LOWER DORSAL and UPPER LUMBAR — AP View or K. P. Center

Refer to Figure Nos. 105 and 108, Pages 295 and 298 for similar placements

Technic
With Bucky

M.A.	KVP	Time	Tube D
10	70	10 sec.	30″
25	70	4 sec.	30″
50	72	2 sec.	36″
100	72	1 sec.	36″

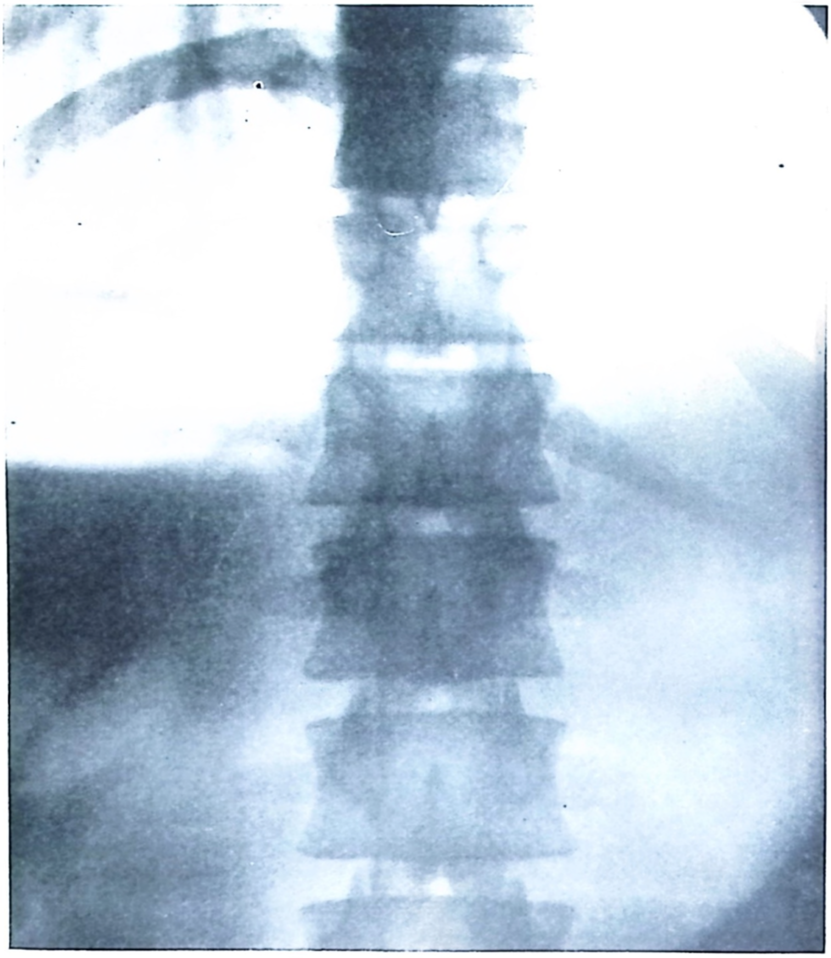


Figure No. 98

LOWER DORSAL and UPPER LUMBAR — AP View or K.P. Center

Film — 8x10.

Preparation — A cotton gown is substituted for the patient's clothing.

Posture — May be either supine, sitting upright or standing. Placement similar to the full spine placement, except in the sitting upright posture, then by visual observation. The cassette is placed so that its inferior edge comes about 2 inches above the superior crest of the ilium.

Tube position — The central rays are directed perpendicularly to the center of the cassette.

LUMBAR — AP View

Refer to Figure Nos. 105 and 108, Pages 295 and 298 for similar placements

Technic
With Bucky

M.A.	KVP	Time	Tube D
10	75	10 sec.	30″
25	75	4 sec.	30″
50	75	2 sec.	36″
100	75	1 sec.	36″

Figure No. 99

LUMBAR — AP View

Film — 8x10.

Preparation — A cotton gown is substituted for the patient's clothing.

Posture — May be either supine, sitting upright or standing.

Placement — similar to full spine placement except in sitting upright or standing posture, then by visual observation. The cassette is placed so the inferior edge of the film comes about 2" below the crest of the ilium.

Tube Position — central rays are directed at center of cassette taking into consideration the contour of the lumbar region of that particular patient.

SACRUM and COCCYX — AP View

Refer to Figure 65, Page 243 for similar placement

Technic
With Bucky

M.A.	KVP	Time	Tube D
10	79	17 sec.	30″
25	79	7 sec.	30″
50	80	3½ sec.	36″
100	80	1¾ sec.	36″

Figure No. 100

SACRUM and COCCYX — AP View

Film — 8x10.

Preparation — Cotton gown substituted for the patient's clothing.

Placement — Supine or standing posture, with the center of the sacral hiatus on the median line. The cassette is placed with the superior edge about 2 inches above the superior crest of the ilium.

Tube position — Central rays should be directed perpendicularly to the center of the cassette or bucky.

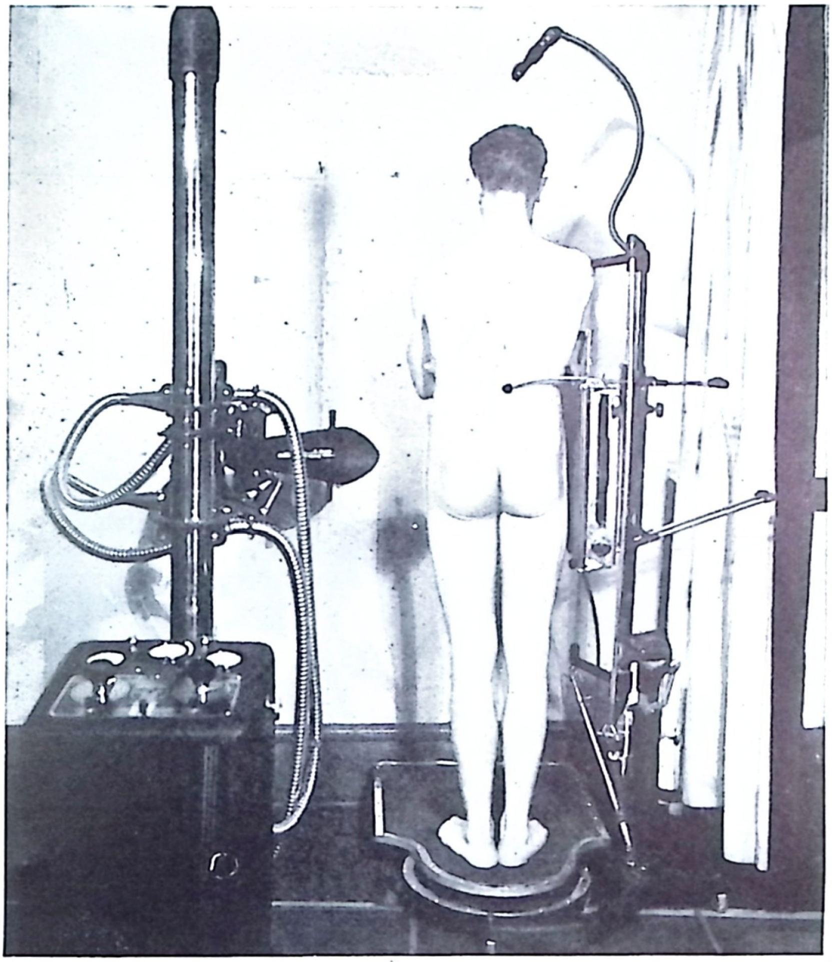


Figure No. 101

SACRUM and COCCYX — Lateral View

Technic
With Bucky

M.A.	KVP	Time	Tube D
10	88	17 sec.	30″
25	85	7 sec.	30″
50	85	3½ sec.	36″
100	85	1¾ sec.	36″

Figure No. 102

SACRUM and COCCYX — Lateral View

Film — 8x10.

Preparation — Cotton gown substituted for the patient's clothing.

Placement — Patient should be either lying on his side or standing. Place the patient so that the sacrum is in the lengthwise center of the cassette. The cassette should be placed so that the upper border is about 2 inches above the superior crest of the ilium.

Tube position — The rays should be directed to the area about 4 inches below the superior crest of the ilium.

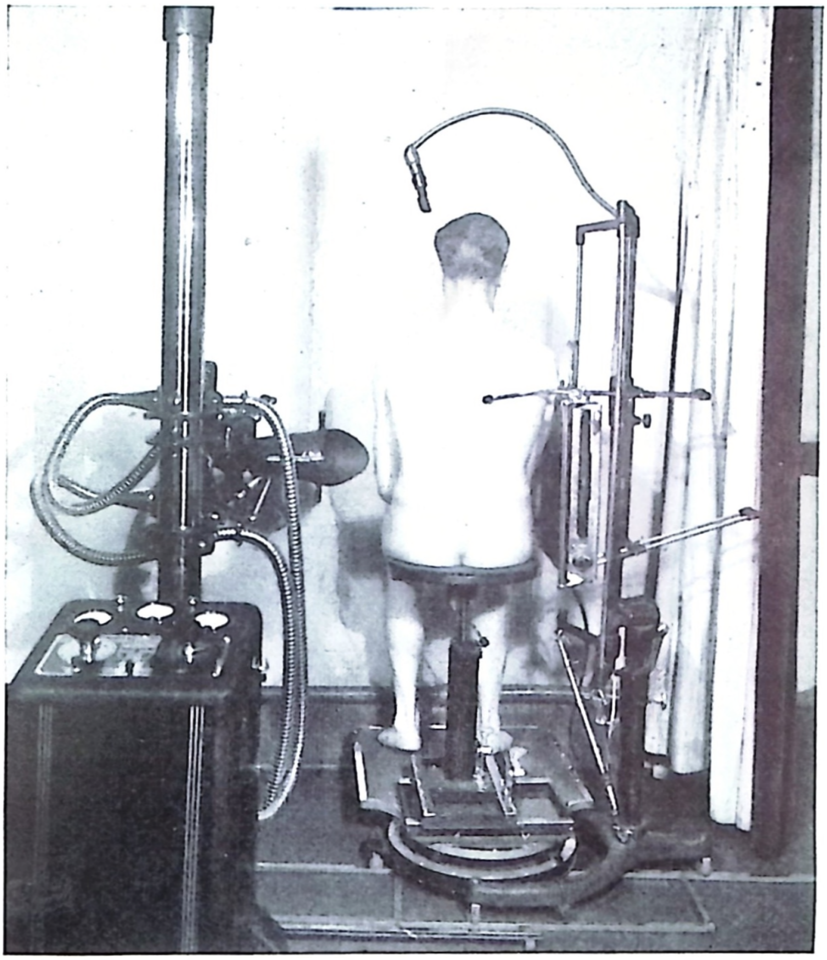


Figure No. 103

LUMBAR — Lateral View

Technic
With Bucky

M.A.	KVP	Time	Tube D
10	85	15 sec.	36″
25	85	6 sec.	36″
50	85	3 sec.	36″
100	85	1½ sec.	36″

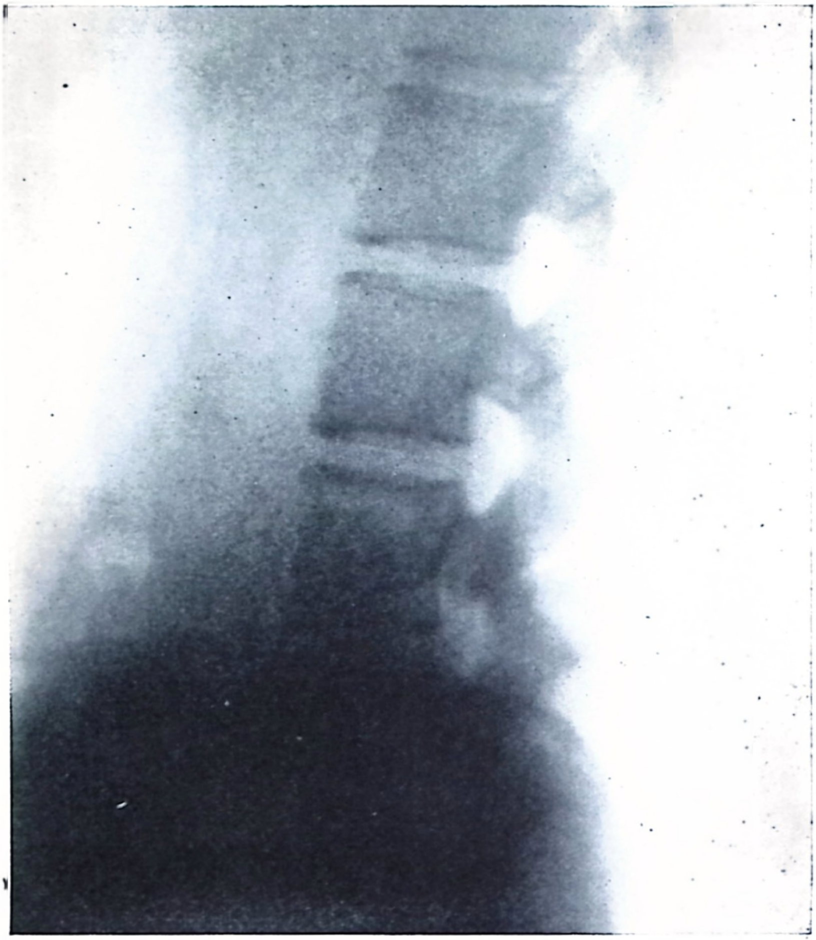


Figure No. 104

LUMBAR — Lateral View

Film — 8x10.

Preparation — Substitute a cotton gown for the patient's clothing.

Posture — The patient may be either lying on his side or sitting upright, sidewise to the cassette or bucky. He should be so placed that the spine will appear in the lengthwise center of the film. The patient should be immobilized during the exposure. The cassette should be placed with the inferior edge about 2 inches below the crest of the ilium.

Tube position — The contour of the spine varies greatly in different individuals. Some have wide hips and small waists; others, narrow hips, large chest and broad shoulders, which will interfere with the normal contour when the patient is lying on his side. The central rays should be directed at the mid-lumbar area so as to reveal the full intervertebral discs without the vertebral bodies overshadowing. In the upright sitting posture, the tube is placed so that the central rays will strike the mid-lumbar area, perpendicularly to the cassette.

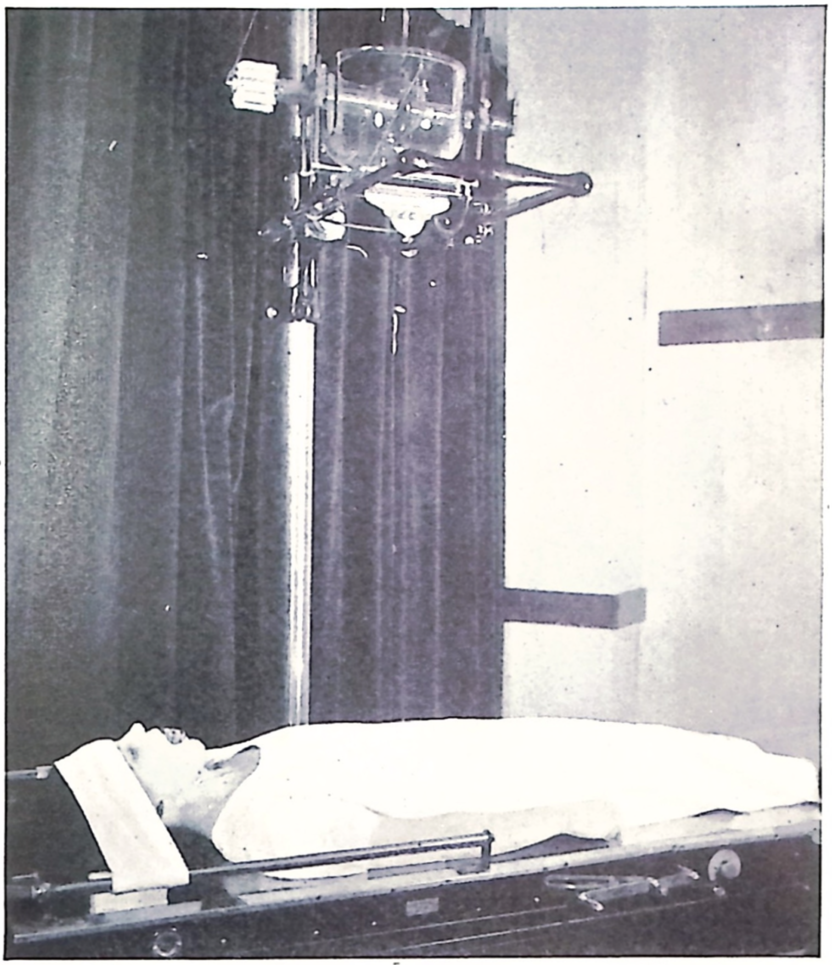


Figure No. 105

FULL SPINE — Supine

Technic
With Bucky

M.A.	KVP	Time	Tube D
10	80	25 sec.	48″
25	80	9 sec.	48″
10	80	30 sec.	60″
25	85	12 sec.	60″
50	85	6 sec.	72″
100	85	3 sec.	72″

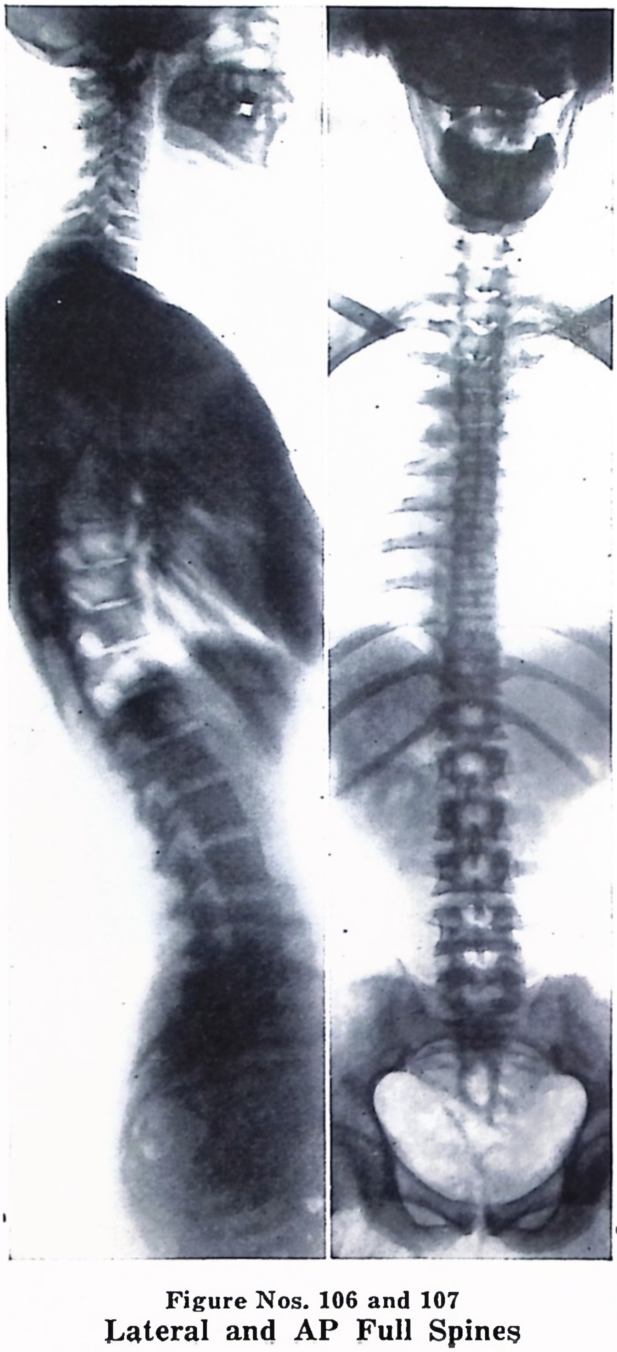


Figure Nos. 106 and 107

Lateral and AP Full Spines

Full Spine — Supine — AP View

Refer to Figure No. 105, Page 295 for film

Film — 8x36, 14x36.

Preparation — A cotton gown is substituted for the patient's clothing.

Posture — The patient is placed in the supine position. Since it is absolutely necessary that the patient be lined up and placed properly in full spine work, great care must now be taken. First the patient is asked to sit on the foot of the table, then to slide back, sitting up until his heels are on the table, and then place the feet an equal distance on either side of the median line. Next, the operator goes to the side of the table, palpates the lower lumbar spinouses and tubercles of the sacrum, and lines them up with the center of the table. This is done by asking the patient to place his hands at his side and raise the buttocks free from the table, which facilitates lining of the sacral hiatus on the median line of the table. The patient is asked to place his hands in his lap. The operator goes to the head of the table places the patient in the supine position by placing his hands back of the patient's shoulders, supporting his weight, and guiding the patient down on the median line. The patient is asked to raise and lower his head. The compression band is applied, and a cork is placed between the teeth if the Atlas and Axis are desired. The cassette is placed so that its superior border is about 3 inches above the pinna of the ear.

Tube position — The tube is centered over the ensiform appendix with the central rays directed toward the lumbar area.

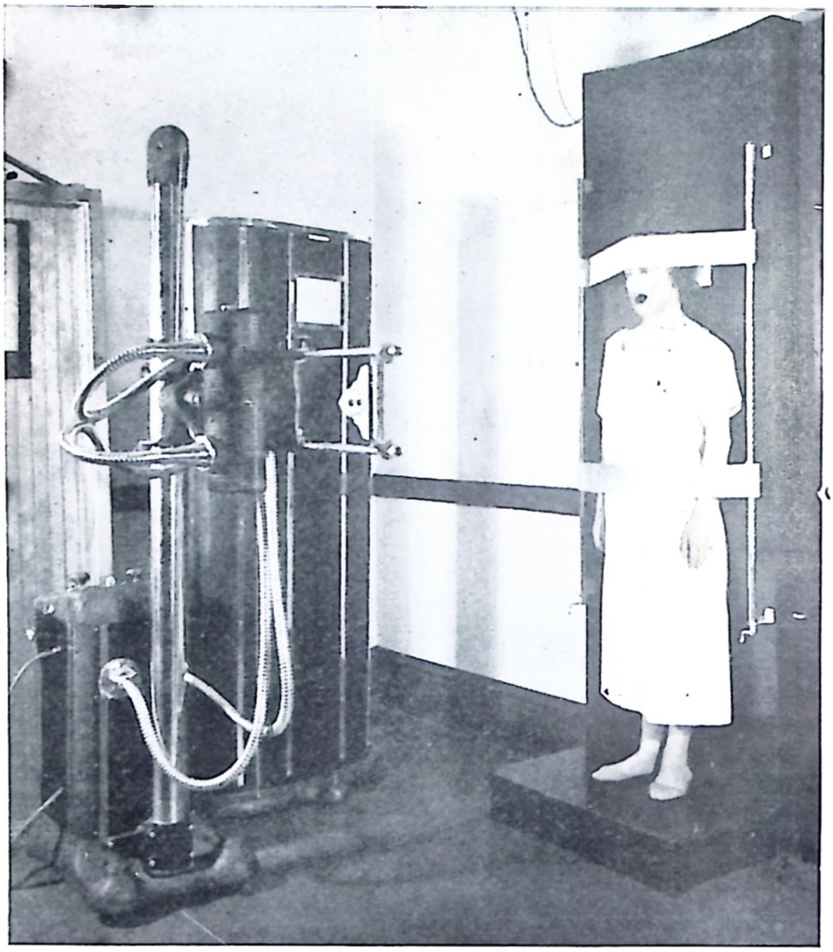


Figure No. 108

FULL SPINE — AP View

Technic
With Bucky

M.A.	KVP	Time	Tube D
10	85	25 sec.	48″
25	85	9 sec.	48″
10	85	25 sec.	60″
25	85	10 sec.	60″
50	85	6 sec.	72″
100	85	3 sec.	72″

FULL SPINE — Upright

Refer to Figure No. 107, Page 296 for film

Film — 8x36, 14x36.

Preparation — A cotton gown is substituted for the patient's clothing.

Posture — The patient is placed with his back against the vertical table or bucky diaphragm, and lined up in relation to the median line of the table by visual observation. Cork pads are placed back of the patient's head for support if compression bands are used. With other types of immobilization units this may not be necessary. The mouth is held open by placing a cork between the teeth if the Atlas and Axis area is to be X-rayed.

Tube position — This should be on an even line with the ensiform appendix, with the central rays directed at the lumbar area.

FULL SPINE — Lateral View

Refer to Figure No. 106, Page 296 for film cut

Technic
With Bucky

M.A.	KVP	Time	Tube D
10	90-100	30-35	60″
20	85-120	20-35	60″
50	75-90	8 sec.	72″
100	75-90	4 sec.	72″

Film — 8x36, 14x36.

Preparation — Clothing removed, cotton gown substituted.

Placement — Patient lying on side, or standing upright, placed so that the shoulder joint and the superior crest of the ilium appear about in the center of the cassette or film. However, there are some exceptions.

Tube Position — Center rays at auxiliary region.

WHY THE CHIROPRACTOR SHOULD SPINOGRAPH EVERY CASE

1—It is a great aid in obtaining Chiropractic results.
2—It promotes confidence.
3—The analysis could not be complete or correct without the spinograph.
4—It eliminates guesswork.
5—It creates interest among patients.
6—It reveals facts, Chiropractically.
7—It procures business.
8—It completes a record of every case.
9—It reveals facts necessary in legal action.
10—It attracts a better class of patients.
11—It adds prestige in your community.
12—It is the proper way to explain Chiropractic.
13—It enables one to talk more intelligently about his case.
14—It is the key to Chiropractic success and health.
15—It reveals the vertebral misalignment.
16—It determines the correct point of contact and proper line of drive for the adjustment.
17—It reveals pathology.
18—It is the only means of knowing whether the vertebra can be adjusted.
19—It enables one to get quicker results.
20—Its use means more permanent results.
21—It should prevent you from adjusting wrong vertebra.
22—It will often eliminate malpractice suits.
23—It will reveal conditions that symptoms cannot.
24—It is often the deciding factor whether or not you accept the case.
25—It builds a reliable reputation.
26—It is a part of the doctor's records.
27—It is an investment and not an expense.
28—It is a scientific procedure.
29—It is absolutely necessary, particularly in atlas-axis specific adjusting.

30—It determines directions in the subluxation that are impossible to palpate or determine otherwise.
31—It proves Chiropractic service is not complete without it.
32—It means the difference between Chiropractic success or failure.
33—It helps to eliminate the so-called starvation period that many practitioners go thru.
34—It provides a quicker way to build a Chiropractic practice.
35—It is being demanded today.
36—It eliminates unnecessary time in your office routine.
37—Its income makes it possible to arrange a better service.
38—It provides a safer and less expensive service.
39—It enables one to care for more patients daily.
40—It provides good interest on your investment.
41—It discloses the other fellow's mistakes.
42—It reveals trauma, anomalies and malformation which the chiropractor must have knowledge of before attending his case.
43—It stimulates the practitioner to greater activity because it eliminates any fear in giving the adjustic thrust.
44—It proves when palpation is in error.
45—It helps to build unity in the Chiropractic profession.
46—It establishes scientific facts in research and experimentation.
47—It is the means of refusing a case when otherwise an adjustment might have done great bodily harm to the patient.
48—It is the only means of knowing how to adjust a particular patient.
49—It provides a method of taking comparative spinographs in Chiropractic service.
50—It proves Chiropractic.

CHAPTER 25

METHODS OF IMPROVING TECHNIC

Perhaps one of the most constant and persistent problems confronting the average Chiropractor in spinographing patients is arriving at a workable solution by which he can consistently get good radiographic views of all his patients. The writer believes that in X-raying the spine, particularly the upper cervical region, there is a greater variation in machine technicalities necessary than in any other type of radiography. Some no doubt will not agree but to get pictures in which you can differentiate between tissue in fractional differences in depth, which is absolutely necessary from an analytical standpoint, requires not only a more intimate study of gross anatomy relative to density from a standpoint of penetration but also a knowledge of the relative density of osseous tissue in the various ages as well as size and weight.

In discussing ways and means of improving a technical procedure it is necessary first to know what is wrong with a film. When examining a developed film it should not be difficult for the spinographer to determine whether it is satisfactory or not, but it might be difficult to tell exactly what has been at fault in the making of the film. Indeed it is obvious that no one particular operation is to blame.

The manufacturers of developer recommend developing films five to six minutes. This requires that a film be properly exposed, using the correct amount of current and penetration with the proper length of tube distance and time.

If the technic was calculated too heavy the film would be over-exposed or too dark, which usually means the exposure time must be reduced and perhaps the kilovolt peak. Always use the least amount of K.V.P. possible, for this cuts down secondary fog. When the film develops too light add to the time or current, or both.

It is a common belief that a rather small room with a suitable, safe light is sufficient for a darkroom and it is, providing there is no natural light leaking in from the corners or around the door. In many darkrooms, shortly after the lights are turned out, the author has detected a shaft of light coming in from over the door, or through a nail hole, or from some other crack or crevice which the operator had not considered important. Yet some of those same individuals who get poor films remark that at night they can develop the films and get better results than during the day. So be absolutely sure that all actinic rays are excluded and use a safe-light that is safe.

Taking for granted that the developing procedure is carried out correctly, observation of the developing film is the greatest means of determining just what is wrong with your machine technic in making the X-rays. Some technicians use an alarm clock to know when the five or six minutes developing time is up, and do not further observe the film at any time during the developing process, little realizing that they are letting slip by the most valuable aid in checking exposure procedures. Very much information concerning the proper machine technicalities in the production of spinographs can be ascertained during the developing process. Four main factors are considered:

Over-Penetration — during the early developing of an over-penetrated film you will notice a muddy appearance of the entire film. A muddy appearance is actually secondary fog. At no time is there a black and white contrast, as the rays have penetrated almost the entire structure to the same degree. Such a film must be removed from the developer at a very early stage in the developing process and then the film will lack detail and contrast though it might be considered readable.

Under-Penetration — meaning insufficient penetration to show definition, soft tissue causing resistance to the rays almost to the same degree as the bony structure. Such a film in the early developing stage would appear very light

and even with little outline of the image itself, and although left in more than the five minutes it will still be lacking in detail, contrast, and differentiation of structure and be of little value.

Over-Exposure — the film over exposed in early developing stage appears black and white, with the white rapidly turning to a darker color. This destroys possible minute structural depth differentiation. Such a film must not develop a full five minutes but should be removed from the developing solution before it becomes too dark.

Under-Exposure — an under exposed film, in the early developing process, appears more or less black and white but does not continue to develop sufficiently to facilitate definition. Like under penetration, this film is of little value.

A properly penetrated and exposed film—should develop a full five to six minutes, the last minute of developing bringing about more detail, contrast and definition. It should be the aim of every technician to arrive at a technic through observation whereby the film will develop a full five or six minutes. This is known as the standard of development.

CHAPTER 26

DENTAL RADIOGRAPHY

Dental radiography is a separate and distinct field of X-ray. To cover this entire subject as it should be, would mean a text in itself. Therefore, the technical procedure described here, will refer only to a general routine in the average X-ray laboratory.

It is impossible to give a definite placement for all dental positions because of the variation in the anatomical structures involved. However, there are certain factors in oral or dental X-ray work which are universally carried out.

Tube and head angulation are the most difficult and important factors; yet, there are certain details to be carried out in placing the film in the patient's mouth.

Dental X-ray films are usually 1¼" x 1⅝" in size, however size ⅞" x 1⅜" can be had for children. These films are often backed with a piece of lead foil to hold their shape. Such films should reveal the entire tooth structure; the crown, the root, and the neck or that part between the crown and the root, and enough of the alveolus and peridontal membrane to interpret the film.

Each individual is normally supplied with two sets of teeth. To have three sets of teeth is rare. The first set is known as the deciduous or temporary teeth which appear early in childhood. The second set is the permanent one. They also appear in early childhood but several years later than the temporary set.

The temporary teeth are twenty in number; four incisors, two canine or cuspids, and four molars in each jaw. The temporary and permanent teeth resemble one another, though the temporary set is smaller in size. The roots of the first set of teeth are, likewise, smaller than those of the second set, while the third molars are usually the largest of the permanent set of teeth.

Authorities claim that the eruption of the temporary teeth takes place about seven or eight months after birth. They are usually complete about the beginning of the third year. Ordinarily the teeth of the upper jaw erupt first, then the lower teeth, second.

There are thirty-two permanent teeth, sixteen in each normal jaw, which proceed at short intervals after the eruption of the temporary teeth. Like the first set, the lower teeth of the permanent set are the last to appear.

Incisors — These are eight in number, four in each jaw; each has a single root. The four directly in front, that is the two upper and the two lower, are sometimes called the central incisors, while the four, lateral to the centrals in the upper and lower jaw, are called the lateral incisors.

Canines or Cuspids — There are four canines or cuspids, two in each jaw or dental arc. Their location is just posterior and slightly lateral to the lateral incisors. These teeth possess only one root. They are longer than the incisor teeth and their roots sink deeply into the jaw bone. The upper canines are similar to the lower except they are usually longer and often larger than the low canines or cuspid teeth.

Pre-Molars or Bicuspids — These teeth usually have a single root. They are eight in number, four in each dental arc and are located just behind and slightly lateral to the cuspids. These teeth are shorter and are very deeply imbedded. The upper set of bicuspids are longer than the lower set and have a tendency towards a double root though they really possess only one division.

Molars — There are six in each jaw, making a total of twelve. They are classed as the first, second, and third molars, the first being the anterior and the third the posterior one. The third molar is often spoken of as the wisdom tooth. However, these teeth are located posterior and slightly lateral to the pre-molars or bicuspid teeth. In the upper jaw the first molar is usually the largest and the third, the last molar or wisdom tooth, the smallest. Each has three roots.

The lower molars are usually larger than the upper. They

possess only two roots. The roots of both upper and lower molars are somewhat fused and the tooth itself angles slightly backward.

Wisdom

The third molars or the wisdom teeth do not appear at the same time as the other molars but near the ages of eighteen to twenty-one years. It is these teeth that often locate themselves parallel with the jaw bone. That is, the crown is more or less forward and the root backwards. This is commonly referred to as an impacted tooth.

Placement

Angulation refers to the alignment of the tube, teeth, and film. It is this factor that makes dental X-ray work often difficult to consistently duplicate the angle. Such angles are

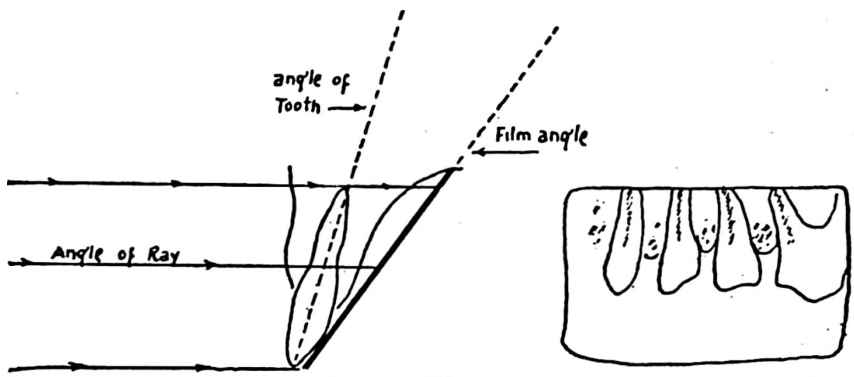


Figure No. 109
Incorrect placement of the tube, upper teeth, and film

only considered correct when the minimum of distortion of the object is obtained. However the rule for correct alignment of the tube, object, and film is as follows:

> **BISECT THE ANGLE, MADE BY THE LONGITUDINAL PLANE LINE OF TOOTH AND THE PLANE LINE OF THE FILM-DIRECTING THE CENTRAL BEAM OF X-RAYS AT RIGHT ANGLES TO THE BISECTING PLANE LINE.**

If the angle of the tube is too great, that is, not at right angles to the film, a shortening of the teeth on the film will result. On the other hand if the tube angle is not great enough an elongation of the teeth will then result.

In dental tube placements of the teeth of the upper arc, the rays are directed above the plane line at right angles to the film. While in the lower arc, the rays are directed below this plane line except for the placement of the molar teeth. In the majority of cases the plane line of these teeth and film are parallel. In this event, directing the rays at right angles to both film and tooth produces the least amount of distortion.

To make a complete oral X-ray examination of a full set of teeth, ten to eleven films are usually required, although

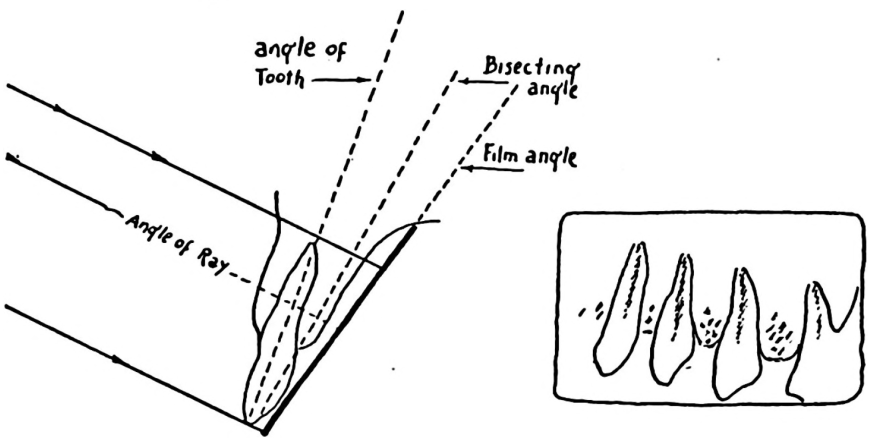


Figure No. 110
Correct placement of the tube, upper teeth, and film

in some cases it takes as many as fifteen. Fewer films would naturally be necessary with more teeth on each film but this would have a tendency towards distortion. Though it is sometimes necessary to use a greater number of films, fewer may be used if the patient does not have a full or normal set of teeth. Perhaps three clear cut teeth, properly appearing on each dental film, makes a film of better diagnostic value.

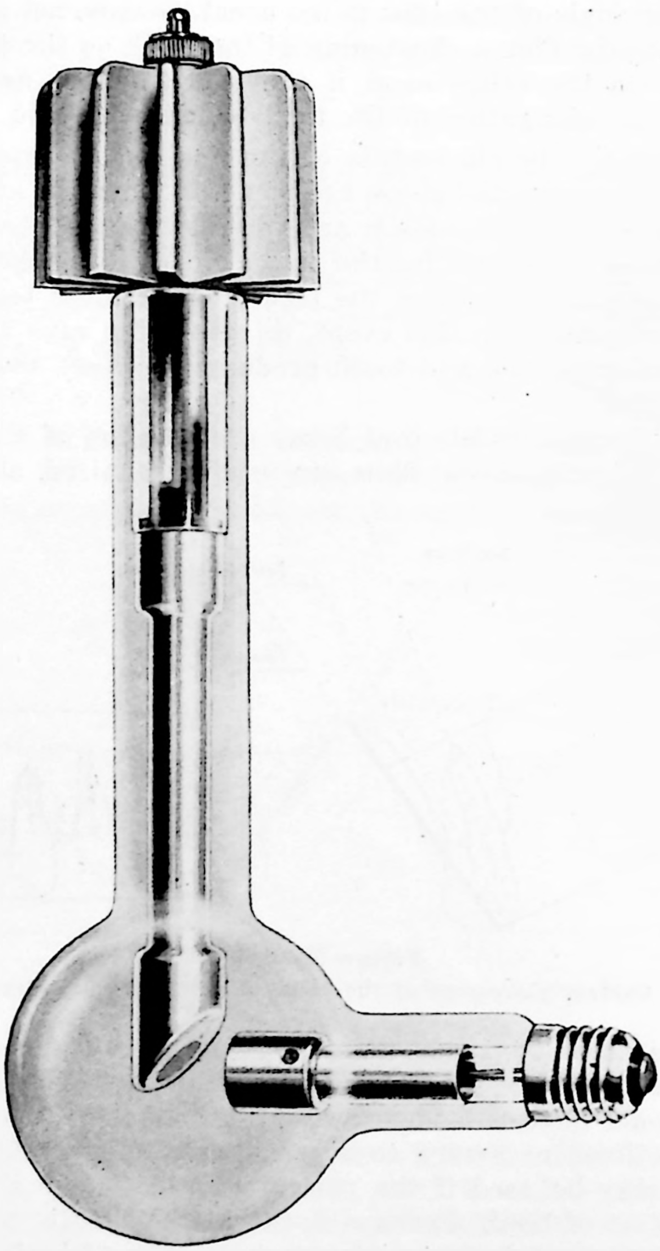


Figure No. 111
Dental Tube — Right angled line and fine focus

When placing the film in the patient's mouth be very gentle. Sometimes the lead-foil backing on the film is rough and sharp; this might cause a slight abrasion of the patient's gums. One should use extra precaution in making placement of the film for pictures of molar teeth, and not allow the film to contact the patient's palate. Such a procedure would invariably cause the patient to become nauseated. To wash your hands, in plain view of the patient, is always a good idea, as they will then know you are clean about your routine and procedure.

Motion is obviously the next greatest difficulty in this work. Usually when motion appears it gives the film a fuzzy appearance and may not reveal a sufficient amount of the root. Such a film may be the result of the film actually slipping in the patient's mouth. This may be due to the method of holding the film.

The most common way of keeping the film in place is to instruct the patient to hold the film with the thumb or index finger. If the right side is being X-rayed the patient holds the film with the left thumb or index finger or vice versa. However, a better method is the use of specially constructed wooden bite blocks. These blocks will suspend the film and will fit between the patient's upper and lower teeth. This minimizes the danger of motion appearing on the film, and assures one of getting more of the roots on the picture. Whichever method is used, the films must be first curved, or bent to approximately fit the angle of contour of the teeth and jaw before they are placed in the patient's mouth.

The position of the patient for dental X-ray work can be either supine or sitting upright. No doubt the latter posture is more universally used; however, the operator who becomes thoroughly familiar with one method in posture prefers that to any other. The upright posture is certainly more convenient for the patient, while perhaps the supine tends to keep the patient quieter. With either the supine or upright posture make amply sure that the wires are well out of

Figure No. 112
Lateral and Frontal teeth

reach of the patient, for the patient's safety must always be your first consideration.

Many operators choose to move the patient's head for the different regions to be exposed. This may be accomplished by either turning the patient's entire body or by just rotating the patient's head. Others prefer to keep the head in the same position and only move the tube. This is, to a great extent, a matter of convenience; however the same general rules are appliable in either case.

Technic

The same factors used for general X-ray work are used in dental procedure, therefore, the same rules relative to distortion, contrast, and density, are completely carried out. As in other X-ray work, there are many combinations of technic given which may vary as much as 10 per cent from being correct. However, the following technic obtains good results here:

Upright posture, using 1 mm. aluminum filter for protection; using the ordinary 3-100 or 5-100 line focus tube, or the right-angled fine focused dental tube.

KVP	MA	Tube Distance	Seconds of Exposure
66-70	10	18″	6
62-68	25	18″	2-2¼
60-66	50	18″	¾-1

Penetration or the amount of KVP is considered the variable. Placement should begin with the central incisor teeth, increasing two KVP as one proceeds. The right angled fine focus dental tube is unquestionably the best to use. It not only tends to make a better quality film but also adds to the safety of the patient.

The dental lead glass cone cut at the proper angle aids materially in getting correct tube angles. It is constructed so as to converge the rays to a small area and too, it adds to the safety of the patient by protecting the face from unnecessary rays.

CHAPTER 27

FACTORS REVEALED BY THE LATERAL, AP, VERTEX, DIAGONAL AND NASIUM CERVICAL VIEWS (Lateral Flat View Tracing)

See Figure No. 112-A

The purpose of displaying the following cuts in this chapter is to bring to your attention the descriptive parts to be considered when making the spinographic analysis, and what view to take to determine certain directions in the misalignment, as well as certain other conditions necessary to know when making the analysis.

These cases are border-line, which means the directions in the misalignment appear slight. These views indicate the upper cervical spine is nearly anatomically normal, insofar as the misalignment is concerned. These views present some idea of what the normal contour is and the relative position of atlas with condyles, axis with atlas and 3rd cervical.

The film from which this lateral tracing was made was placed against the patient's right shoulder with tube directing the rays from left to right, although whichever side is convenient to place toward the film is all right just so the one reading the film knows which side of the case he is looking at. It is generally understood that whichever side is closest to the film is the side first visible when viewing the negative. However, when pathology exists that particular side must be closest to the film.

When placing this patient for the lateral spinograph, it was necessary to manually rotate his body to get certain alignment of the head because he carried his head in a rotation and lateral tilt. Incidentally, a large percentage of people carry their head in such positions. Further it was necessary to angle the bucky diaphragm because of the lateral tilt. So rather than deliberately turn the patient's head to make certain alignment, manually rotate the pa-

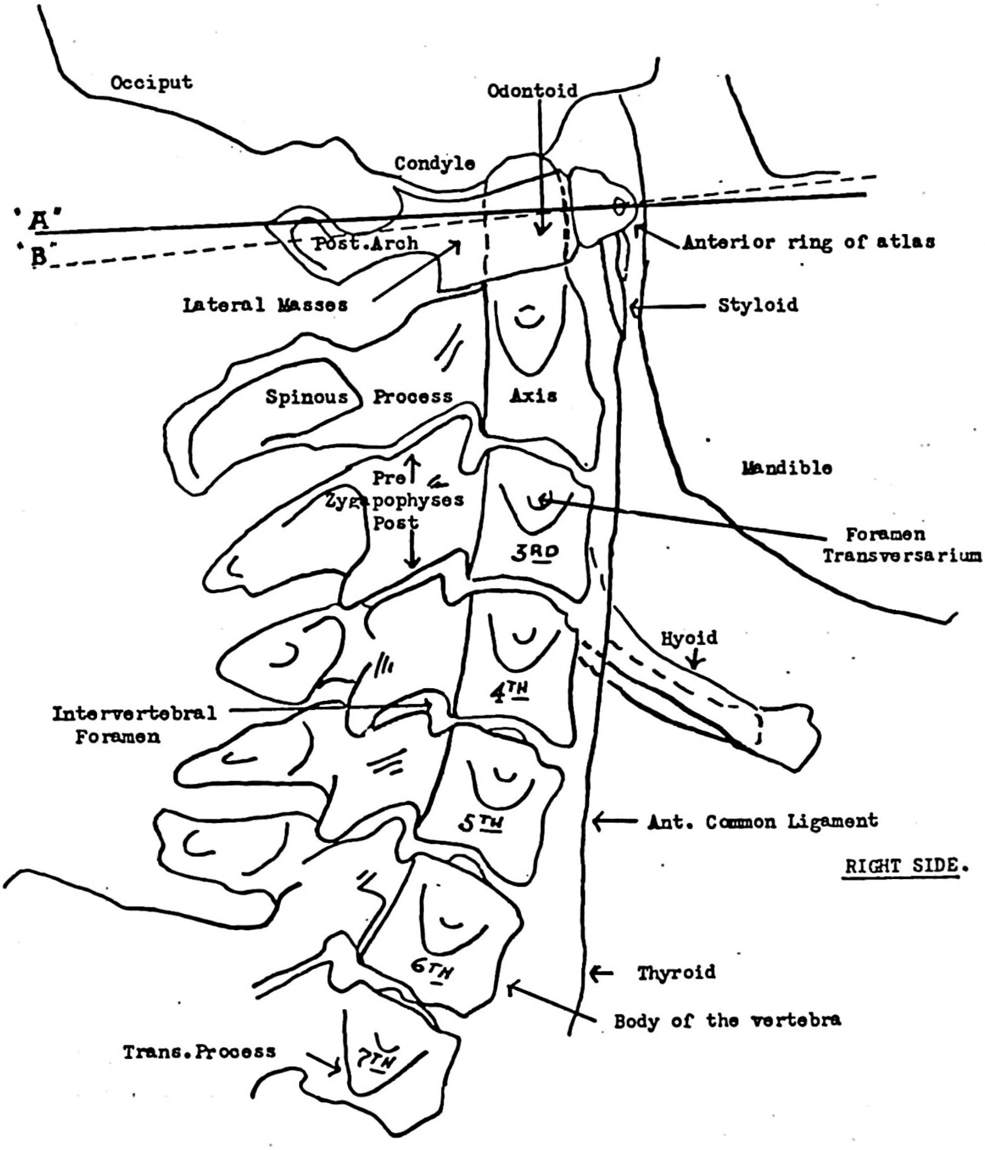


Figure No. 112-A

Lateral Flat View (Tracing)
Contour and Spinal Alignment nearly normal or border-line

tient's body, tilt the bucky diaphragm if necessary and keep the head in its normal position to that particular individual.

To read atlas in relation to condyles, an imaginary plane line laterally through condyles (when placing the patient) should be at right angles to the film's surface. THE USE OF THE MODEL "R" CASSETTE HOLDER WITH 8 x 10 BUCKY DIAPHRAGM MAKES THE PROCEDURE VERY CONVENIENT AND ACCURATE. Incidentally the plane line drawn through atlas on lateral view is usually from posterior tubercle thru center of anterior arch. In this case the posterior arch is malformed and the correct plane line is indicated by the dotted line "B".

This case was spinographed in the vertical or upright position and the primary rays were directed slightly inferior to the external auditory meatus.

The following factors are indicated by the lateral cervical flat or natural view.

1—Anteriority
2—Superiority or inferiority of atlas
3—Posterior inferior axis
4—Anterior or posterior curvatures
5—Impacted or abscessed molar teeth
6—Tilt or rotation of head
7—Anomalies or malformations as seen from this view
8—Indications of rotated atlas and axis
9—Enlarged and infiltrated thyroid
10—Fractures and dislocations from this aspect
11—Ossification of the posterior atlanto-occipito ligament
12—Exostosis and ankylosis as seen from this view
13—Possible skull tumors, protrusion of the spinal cord, etc.
14—Head rotation
15—Visibility of posterior and anterior common ligament
16—Visibility of the styloid and hyoid bone.

AP FLAT VIEW TRACING

See Figure No. 112-B

The film indicating this view was placed at the posterior in contact with patient's head and shoulders with patient sitting normal. Although the atlas and axis in AP cervical film is usually placed near a horizontal center of the film to show nasal and orbital cavities, etc., this one was deliberately placed lower to reveal all the cervical vertebrae from this aspect. The right side of this cut is in accordance with patient's right side. Incidentally, the reading is made from posterior to anterior. In other words, the one making the analysis looks through the film from posterior to anterior and his right side is then in accordance with the marker on the film which should be patient's right side.

The tube was positioned to direct the X-rays from anterior to posterior. The direct path of primary rays were angled to strike the film at right angles to the vertical center of the film or nearly so, and in line with the lower border of the patient's mastoid process. The angle of the direct path of primary rays may be slightly disregarded if patient has an extremely low occiput, large or gold crowned teeth or cannot open his mouth sufficiently wide without producing strain or tension of the cervical soft tissues. Incidentally, the patient's mouth was kept open during the exposure by the use of the proper size cork.

The normal position of the patient's head was determined when he was seated by asking him to turn his head left, then right, then look straight forward. He directed his line of vision straight forward by moving or rolling his eyes but his head was not in accord. So manual rotation of his body was necessary to align the frontal groove and external occipital protuberance with one another and then it was necessary to shift his entire body manually and laterally to get this alignment in the direct path of X-ray. Dentures were removable so they were removed. Incidentally, all ear rings, hair pins, bobby pins, necklaces and body pins, should be

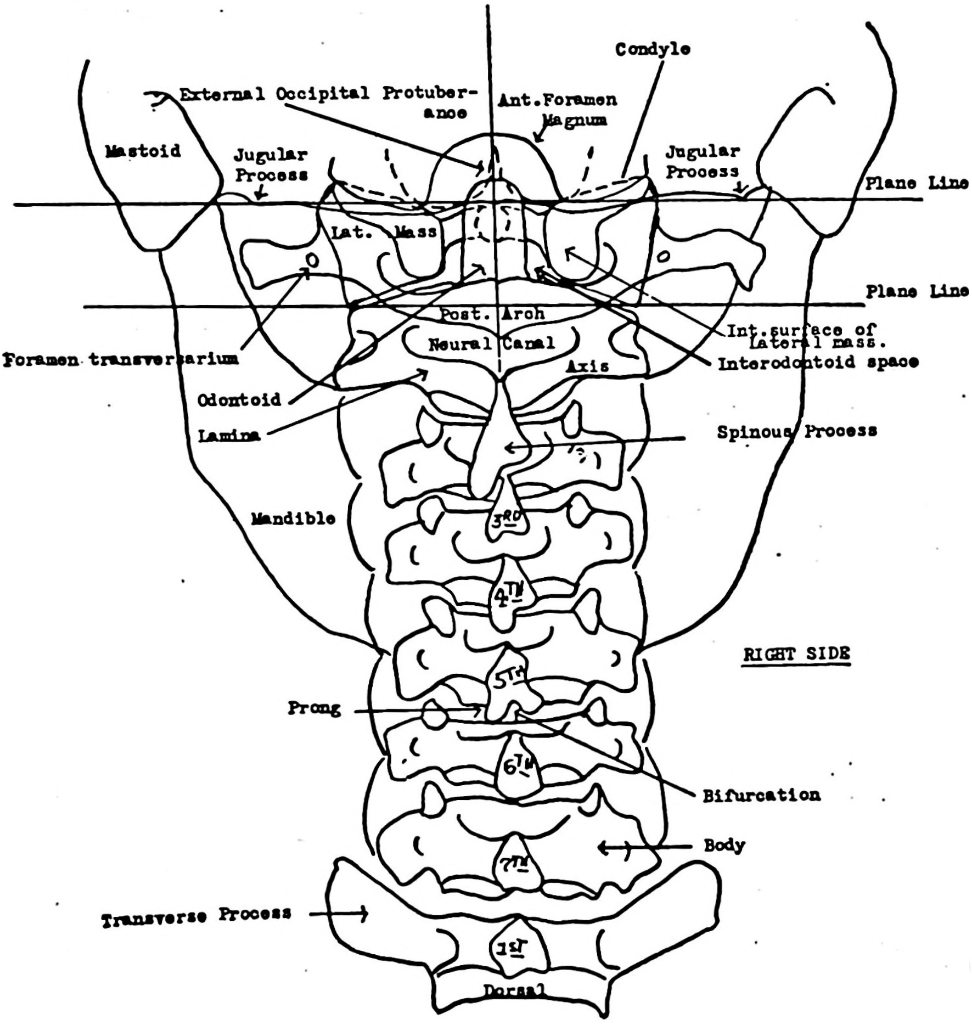


Figure No. 112-B

A to P Flat View (Tracing)
Contour and Spinal Alignment nearly normal or border-line

removed if they are within the region to be X-rayed and analyzed.

Bear in mind the stereoscopic views add depth and will result in greater perception of this factor.

The following factors are indicated by the AP view:

1—Any rotation of head
2—Lateral tipping of the occiput
3—Atlas laterality, sideslip or point of wedge.
4—Indications of atlas rotation
5—Axis body pivots
6—Laterality of axis body or spinous process or both
7—Rotation and lateral tipping of the body of axis
8—Anomalies or malformations from this aspect
9—Straight lateral tipping of entire cervical spine with or without rotation.
10—Impacted or abscessed molar teeth
11—The marker indicates right side of patient
12—Curvatures or plain rotation of 3 or more adjacent vertebrae rotated in the same direction
13—Fractures and dislocations from this aspect
14—Extension of jaw left or right with rotation or tilt of head or as the result of anomaly only
15—Styloid process visibility
16—High or low atlas on side of atlas laterality, etc.

VERTEX FLAT PA VIEW (TRACING)

See Figure No. 112-C

These views are made to determine the rotation of atlas and verify the indications of this direction as revealed by the flat AP cervical spinograph. When placement for this type is correct there should never be any doubt as to the rotation of atlas. This view may also indicate laterality of atlas and rotation of axis. Further it should give one an idea of the alignment of the 1st and 2nd neural rings. In other words, looking into the 1st and 2nd neural rings (vertebral canal) one should get an idea of not only the alignment of these parts but which one of the two vertebrae protrude into the canal more than the other and which vertebra may be causing the pressure.

Note where or which side the pressure is found and compare with the internal margin alignment of condyles, atlas and axis. Incidentally, far better results are obtained by the use of the Neurocalometer or Neurocalograph and the spinograph than without; the Neurocalometer or Neurocalograph to indicate where and when interference exists and the spinograph will reveal which vertebra to adjust, where to make the proper contact and direct the line of drive.

This vertex view is schematic revealing no rotation or tilt of the head, no rotation or tilt of atlas or axis with both atlas and axis in the median line. Normally the median line, as seen on this view, extends from the external occipital protuberance up through the center of axis and atlas, basilar process and through the center of the nasal cavity. The line bisecting the transversarium foramen should be at right angles to the median line. The irregularities revealed here are the transverse processes of atlas and the bent spinous process of axis. The junction of laminae however, is in the median line.

The vertex film can be placed anterior or posterior to the head. As the objective is reached in either event, the following remarks will apply to the anterior position of film.

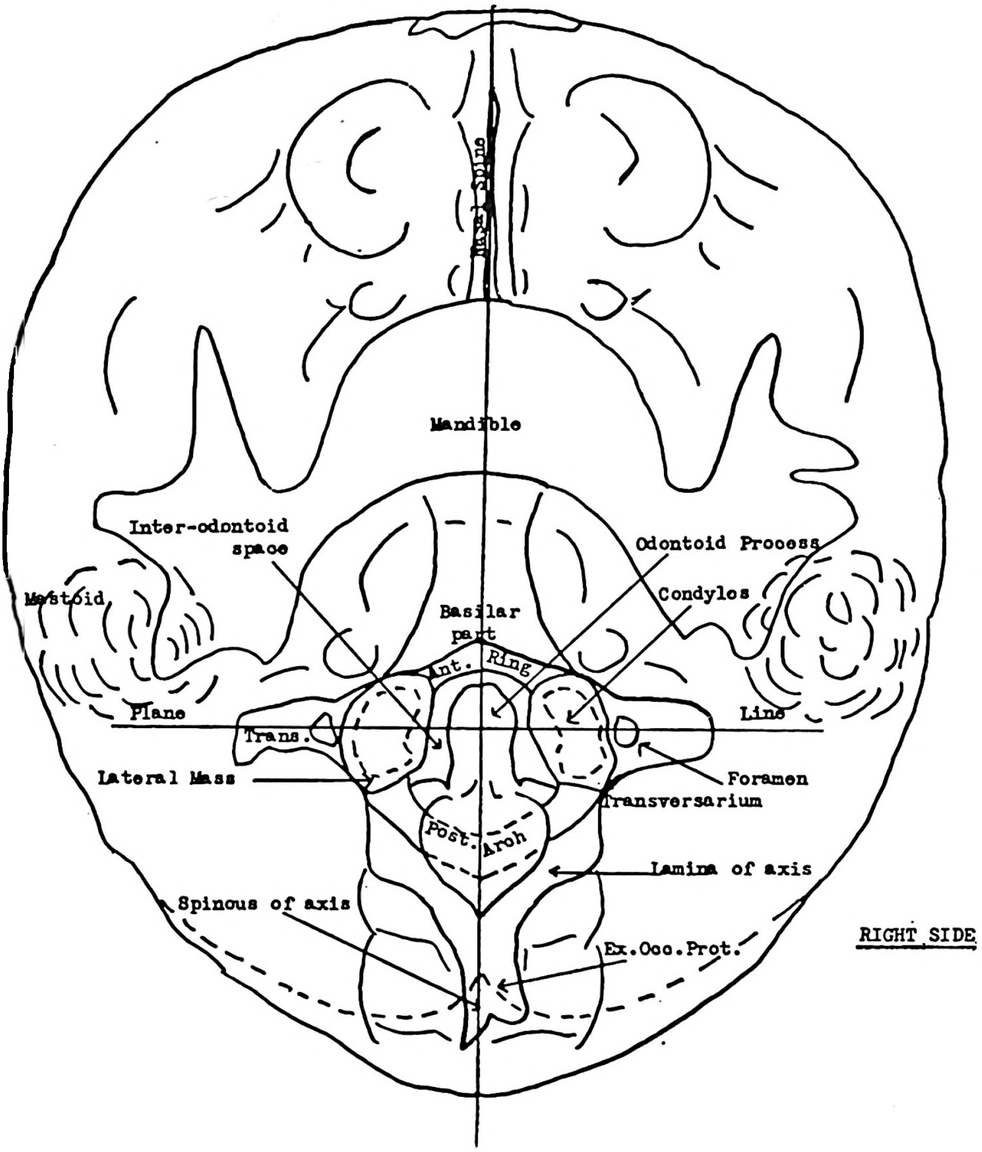


Figure No. 112-C

P. A. Vertex Flat View (Tracing)
Contour and Spinal Alignment nearly normal or border-line

Caution and precision are demanded in the taking of this view the same as of any spinograph. The patient is placed in the upright position and body rotation manually removed. The necessary angle of the head which might be acquired by elevating the chin is usually obtained by having the patient bend forward at the hips and not by simply forcing the chin up and the head back. The chin should contact the center of cassette about two inches inferior to the superior border of the film. This usually places the anterior arch of atlas nearly in line with the horizontal center of the film or slightly below.

The angle of the tube depends on the angle of the head relative to the film. But usually the tube is positioned to direct the path of primary rays in line with the lower border of the mastoid to a point on the film about two inches below the chin. However as all patients are different this requires something different in the technic and placement so naturally the same angle may not exactly suit all cases. It is often necessary to take the second picture not only for correct angles, etc., but to get a more readable film for some skulls are more difficult to penetrate than others.

Factors indicated by the vertex are as follows:

1—Atlas rotation
2—Axis rotation
3—Indications of atlas sideslip
4—Indications of laterality of body of axis
5—Anteriority of atlas
6—Anomalies and malformation from this aspect
7—Pivoted atlas (degree of anterior rotation greater than degree of posterior rotation)
8—Tilt or rotation of head.

DIAGONAL FLAT VIEW (TRACING)

See Figure No. 112-D

This type of radiograph offers more valuable information in a stereoscopic set than the regular flat spinograph. It is particularly valuable in reading atlas rotation when a great deal of malformation and variations throughout condyle-atlas articulations exists. Then too it makes an ideal view for better visualization of dislocations, fractures, or pathology within this area.

In the event one suspects pathology, fracture or dislocation, it is advisable to place this type of film with that side in close proximity to the film. In fact this is true of any lateral film also. Very often certain conditions are revealed on a diagonal spinograph that was not visible on one of the other films. However, the analyst must know which side of the case he is viewing when he attempts to read diagonal films.

There are five factors to know before attempting to analyze diagonal views. They are as follows:

1—At which side of patient the film was placed.
2—From what angle visualization is being made.
3—Whether or not there is any rotation of axis.
4—The point of wedge or direction of atlas laterality.
5—The anomalies and malformations visible by other views.

Factors indicated by the diagonal spinograph are as follows:

1—Atlas rotation
2—Anteriority
3—Superiority and inferiority
4—Curvatures
5—Exostosis and ankylosis
6—Fractures and dislocations, etc.

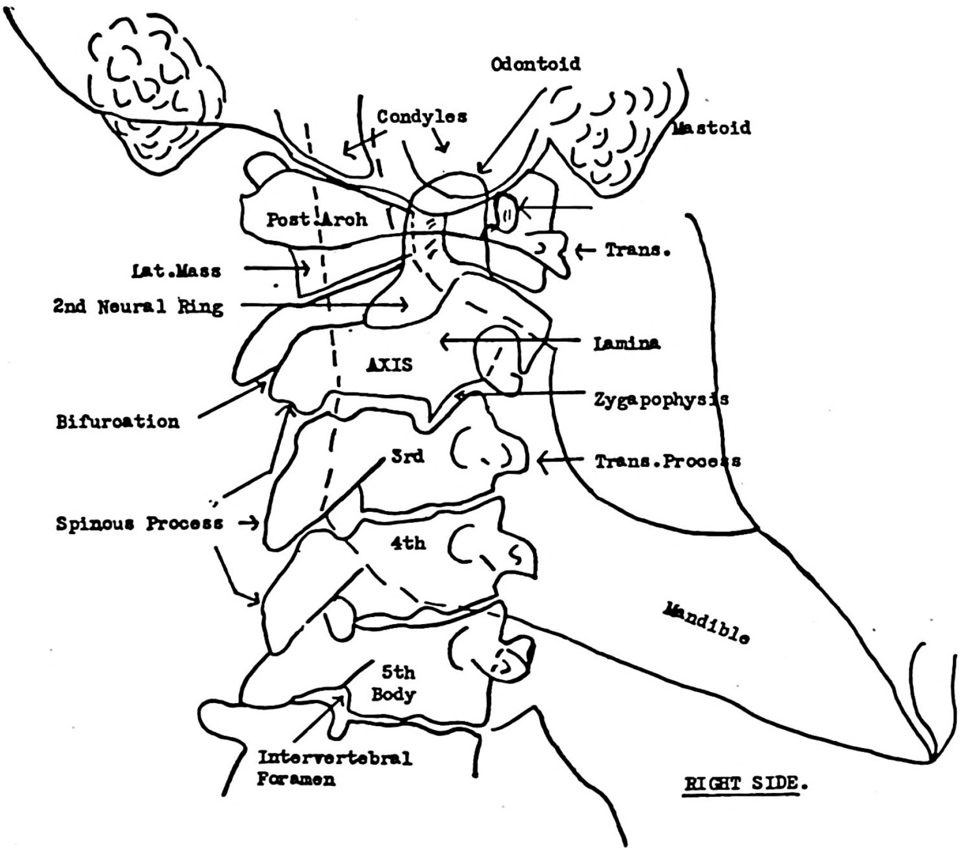


Figure No. 112-D

Diag. Flat View (Tracing)
With R. shoulder closest to film. Rotation made 35° towards the tube.
Contour and Spinal Alignment nearly normal or border-line.

NASIUM, AP FLAT VIEW (TRACING)
See Figure No. 112-E

It was not the intention to break the continuity of this chapter by displaying spinographs other than those nearly normal. But since this tracing represents a very unusual and most interesting case in radiography, certainly it will suffice in the explanation of a nasium flat spinograph.

The writer has taken and read thousands of X-rays, served as a technician in several hospitals but in his 30 years of experience has never had the opportunity of assisting in the taking of such a radiograph or witnessed such a delicate operation.

This patient was sent to a hospital for an X-ray examination of his skull because he had symptoms of brain tumor. Evidently the examination proved the physician's contention for he was operated as indicated by this cut.

Two holes were drilled in the back of this patient's head, air was pumped into his skull and radiographs taken; then an opening made posterior and superior to his right mastoid. It was found that the opening wasn't large enough, so a portion of his skull was chiselled out to extract the tumor. How wonderful is the science of X-ray and what it means to the professions in the restoration of health.

The idea of a nasium for Chiropractic purposes is just another view to verify the rotation of atlas and axis, particularly the laterality of atlas and body of axis. It might be a little more difficult to read the A to P or vertex flat mainly because there is more formation to obstruct visualization of certain descriptive parts. However, a complete study of this type of spinograph will reveal that it is advantageous in checking the findings of the regular AP view. This is particularly true when there is a great deal of malformation or the misalignment is minute.

The same precaution must be exercised in placing the case for this type of spinograph. It may be made either upright or supine, preferably upright. The placement is with the mouth closed, point of chin and forehead on the same plane

as the film surface; tube centered over nasal cavity or inferior to the bridge of the nose. Incidentally, better results will be obtained by increasing the tube distance to 48 inches or even more.

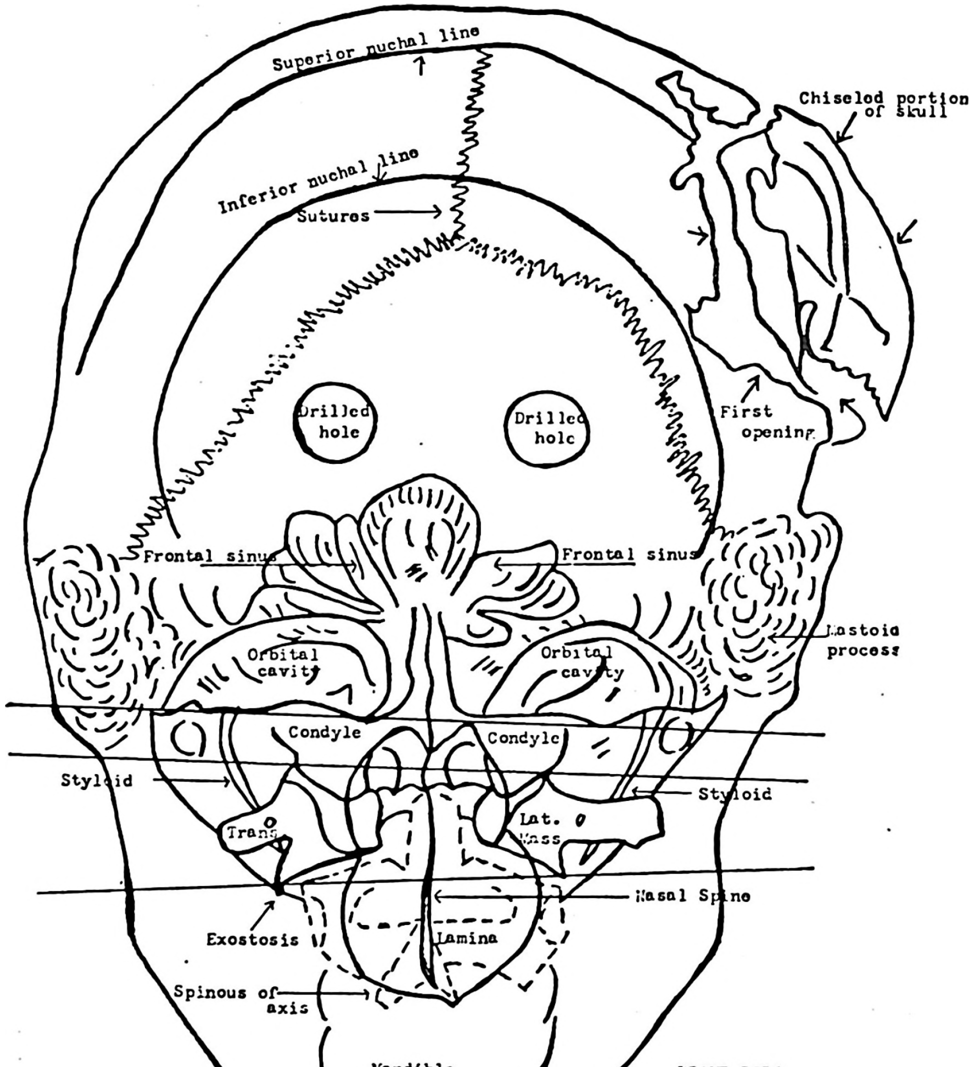


Figure No. 112-E
NASIUM
(A to P Flat View Tracing)

CHAPTER 28

THE AXIS

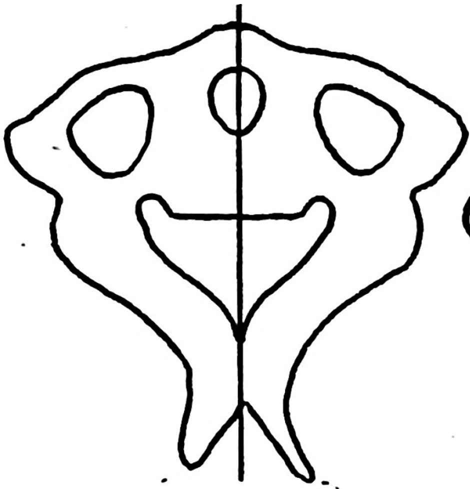
(Epistropheus)

The axis is peculiar and is the second spinal vertebra. It is larger than the atlas although its neural ring is smaller. It is a symbol of strength and support. It forms a pivot upon which the atlas rotates. It protects the extreme upper portion of the medulla spinalis and its dens is in close relation to the lower portion of the medulla oblongata. This means the axis may produce pressure or interference directly against the medulla oblongata as well as the spinal cord.

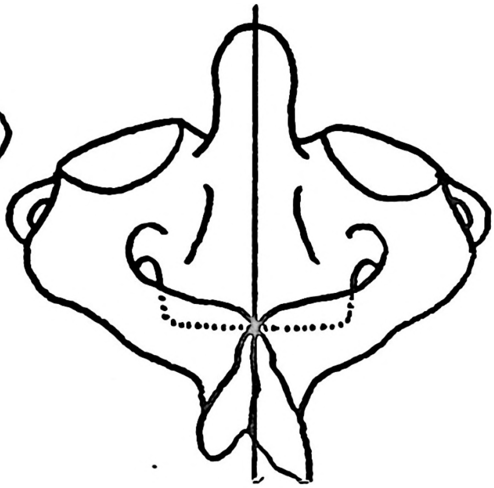
The axis moves abnormally in many directions. Altho heretofore the listings have only been PL or PR, so to speak, such listings do not supply sufficient information to adjust axis. In other words there are many combinations of directions in its misalignment or subluxation. With its neural ring smaller than that of atlas, it would seem there is greater possibility of pressure made against the cord than pressure made by atlas against the medulla oblongata. Then too, with such close relationship of the odontoid, the medulla oblongata and spinal cord it is only logical to assume the axis should have first consideration in the adjustment.

Axis is the key to listing atlas because its subluxation will change all spaces and alignment relative to atlas. Therefore always list axis first when reading the upper cervical spinograph. IT IS THE OPINION OF THE WRITER THAT IF MORE AXES WERE CONSIDERED AND THEN PROPERLY ADJUSTED, ATLAS AND AXIS SPECIFIC WOULD ACHIEVE EVEN GREATER RESULTS.

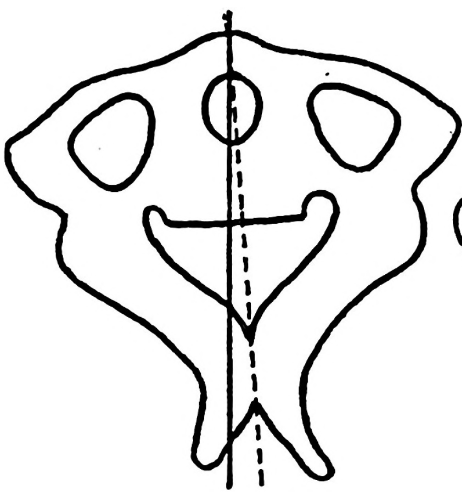
Unfortunately this type of Chiropractic service often turns out to be just another method among our rank and file because specific contacts and lines of drive were not made. Atlas and axis specific calls for and demands a particular and specific procedure. It is one often difficult to



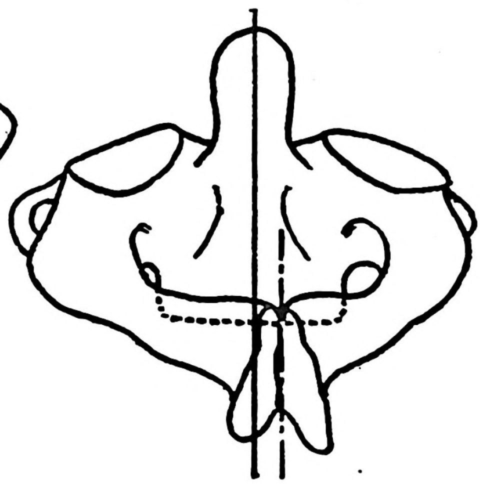
(SUP. VIEW)
NORMAL AXIS
Figure No. 112-F



(A-P VIEW)
NORMAL AXIS
Figure No. 112-G



AXIS RT.—BODY PIVOT
Figure No. 112-H



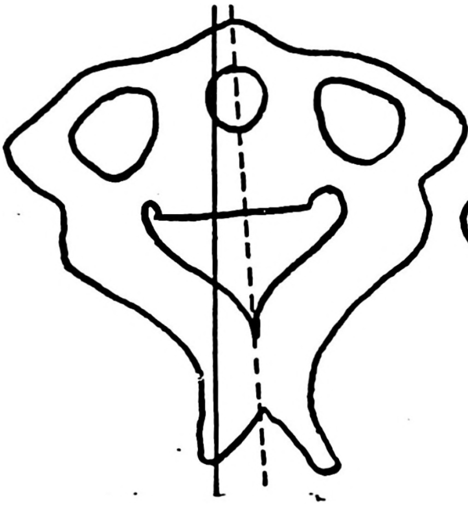
AXIS RT.—BODY PIVOT
Figure No. 112-I

follow. When the procedure is not correct then this type of service will not achieve satisfactory results. In this event the usual criticism is that the system is all wrong. BUT B.J. PROVES THROUGH THE USE OF SCIENTIFIC EQUIPMENT THAT THE PRINCIPLE IS SOUND AND CORRECT. Then the fault lies within the chiropractor himself; he has failed to make it work. Why? Perhaps axis should have been adjusted instead of atlas, or axis was not adjusted correctly, or the spinographic analysis may not have been complete in detail, or the adjustic thrust was not made in accordance with the laws of mechanics. There may have been no mechanical perception, it could have been lack of cooperation or a tremendous amount of damage already done which naturally caused results to be slow, or perhaps not apparent. On the other hand it could have been the case was not a Chiropractic one. Then too physical inability on the part of the chiropractor presents another problem. So there are many angles to be discussed in upper cervical specific work.

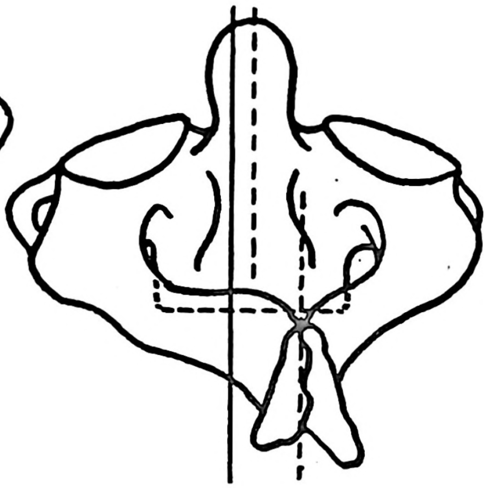
Each day these problems are called to my attention. Perhaps the most prominent of all is mechanical perception, although I might add—"which vertebra should I adjust?"—the "inability to make proper contact" and last but not least "impatience".

Mechanical ability and the perception thereof is vitally necessary in both spinographic reading and to perform the adjustment. It is so important that it means the difference between Chiropractic success and failure. To read the spinograph correctly is one thing, to know how to adjust the vertebra to correct the misalignment is another. Incidentally, the procedure in correcting the misaligned atlas or axis is usually more difficult than for any other segment in the spine. This is because of their structure, their peculiar manner of moving and the limitations in their misalignments are not as great.

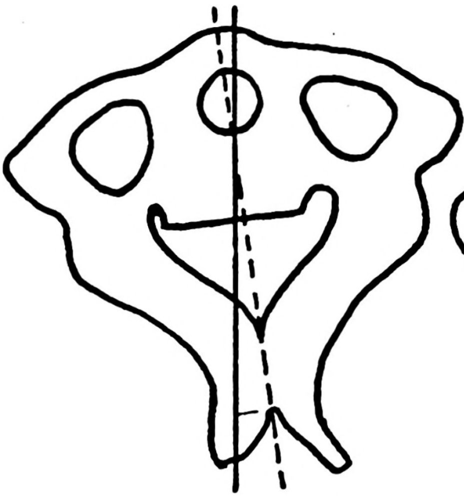
It is not uncommon to hear the following conversation in my office: "You say you adjusted according to the analysis



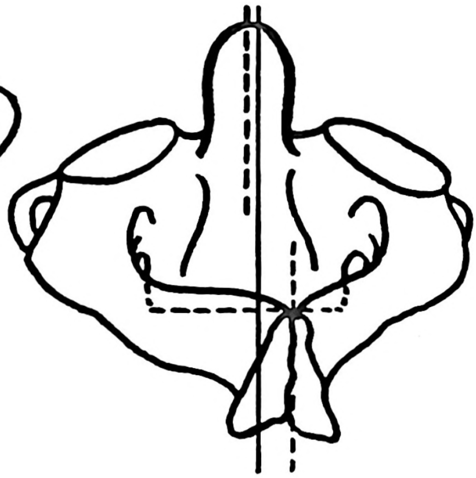
AXIS RT. Body Pivot BODY RT.
Figure No. 112-J



AXIS RT. Body Pivot BODY RT.
Figure No. 112-K



AXIS RT.-BODY PIV.-BODY LT.
Figure No. 112-L



AXIS RT.-BODY PIV.-BODY LT.
Figure No. 112-M

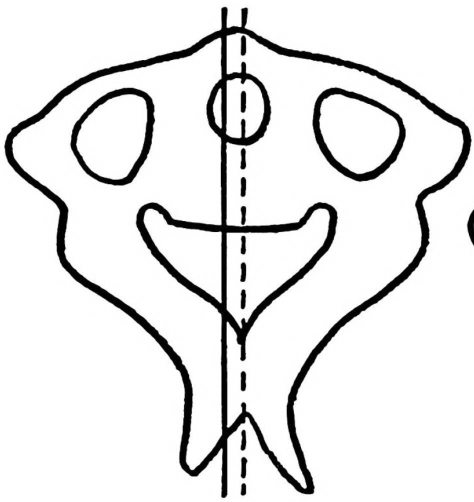
with no results, but did you figure out just how the vertebra moved to its misaligned position and how it must be adjusted to correct that particular vertebral misalignment?" "No". "Well, remember that simply the letters in the analysis does not imply sufficient knowledge to make the proper and correct adjustic thrust".

Each case is individual, therefore each adjustment must be an individual one. One must not only know the direction in which the vertebra moved out, but also know how it moved out and exactly what contact and line of drive to make to move it back towards its normal position.

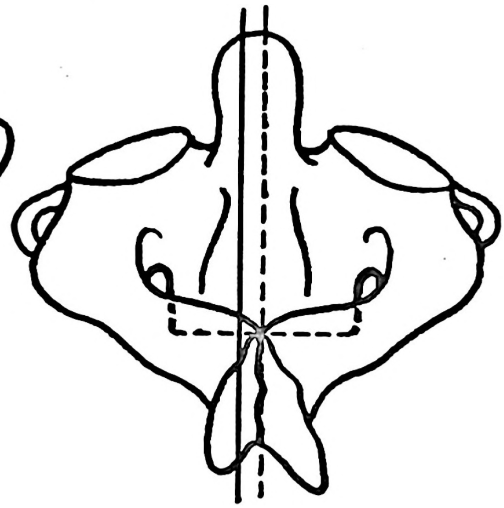
Necessary and correct spinographic views will reveal the misaligned directions and your mechanical perception will tell you where to make the contact and direct the proper line of drive to correct it. I might say that if the competent analyst would include contacts and lines of drive in his written report, and then if the chiropractor would follow through to the best of his ability, better results would be obtained.

Due to osseous structures, muscular attachments, etc., it would seem that atlas should follow axis rather than axis follow atlas. However, both atlas and axis follow the skull to some degree in all its range of normal motion, the atlas more than axis. The condyles act as guides in the mobility of atlas. In other words, which ever direction atlas moves, it does so in relation to the contour of the condyles, axis in relation to atlas and 3rd cervical. Atlas and axis will rotate and move laterally in opposite directions though perhaps they move alike (in the same direction) in at least 50 per cent of the cases. They have greater range of normal motion backward and forward than rotating from side to side.

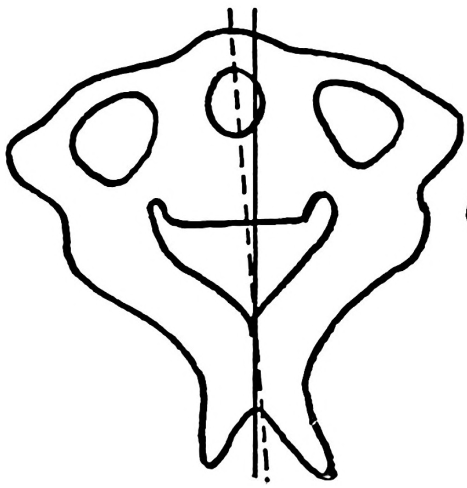
May I repeat—it is a common occurrence to hear someone exclaim, "I adjusted axis according to the analysis and the patient is no better, or even worse". In almost every case I find the listing correct but the axis was not adjusted correctly, or perhaps the atlas should have been the vertebra to adjust.



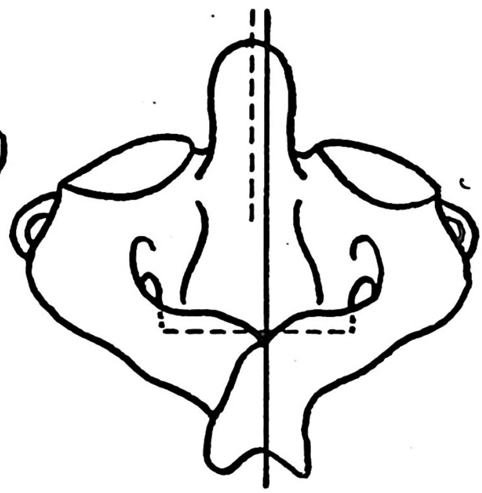
AXIS-NO. ROT.-Entire Vert. RT.
Figure No. 112-N



AXIS-NO. ROT.-Entire Vert. RT.
Figure No. 112-O



AXIS BODY L.-SPINOUS PIVOT
Spinous VERY SL. RT. of its Body
Figure No. 112-P



AXIS BODY L.-SPINOUS PIVOT
Spinous VERY SL. RT. of its Body
Figure No. 112-Q

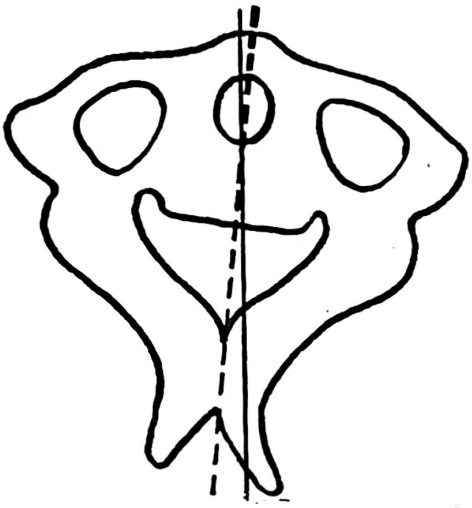
The most prominent of all axis misalignment is the body pivot, spinous right or left of its own body with the odontoid in the median line or nearly so. When this type of misalignment is adjusted good results usually follow. No doubt this is because it is a spinous contact which of course is the easier axis contact point to locate and adjust. However, to be specific the contact should be as far to the posterior of the spinous as possible and the line of drive should angle so that the drive without any force applied directly right to left or vice versa forces the contact hand nearly off the spinous process, so to speak. This should rotate the body bringing the spinous in line with the center of its own body and in the median line without moving the odontoid out of the median line. This should be a recoil adjustment. A rotary move should never be applied to this type of misalignment because in giving a rotary there is always force applied against the body in order to move or swing the spinous toward the median line. Even though some may believe there is merit in a Bench T.M. move, it should not be applied to this type of axis pivot.

Never use an upright cervical break move, because the amount of leverage is terrific and there is absolutely no control of the vertebra whatever. Such a move moves all cervicals every which way. It is as unorthodox as the old cervical shakeup which was taught years ago by some schools.

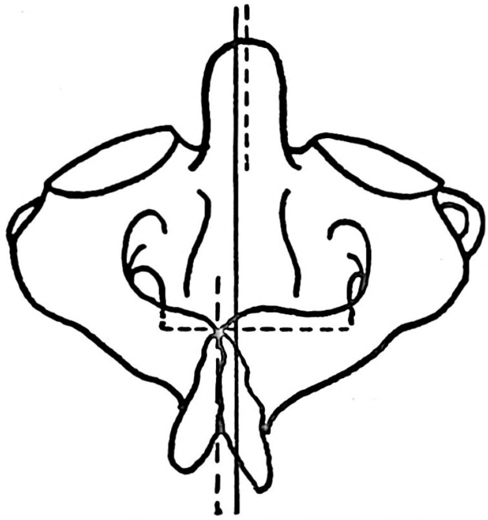
Figures 112-F and 112-G indicate the normal axis.

Figures 112-H and 112-I reveal the body pivot with odontoid in median line.

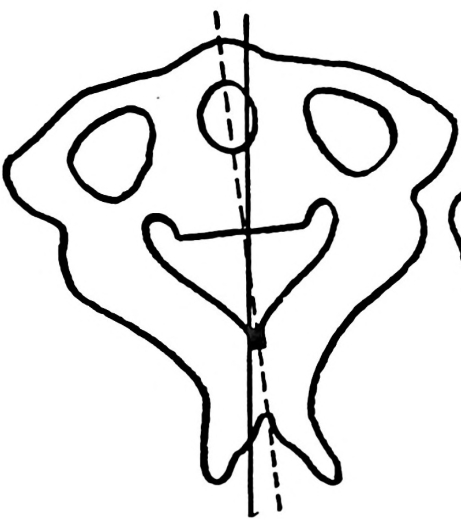
Figures 112-J and 112-K reveal body pivot with entire vertebra right. Spinous has moved more right of the median line than the odontoid. In view of spinal mechanics this calls for a different contact and a different angle of drive. This adjustment must move the entire vertebra towards the median line but the spinous more than the body. Contact should be on the lamina with sufficient angle to the drive to rotate the body yet allow sufficient force to move the body laterally toward the left. In all probability an adjustic



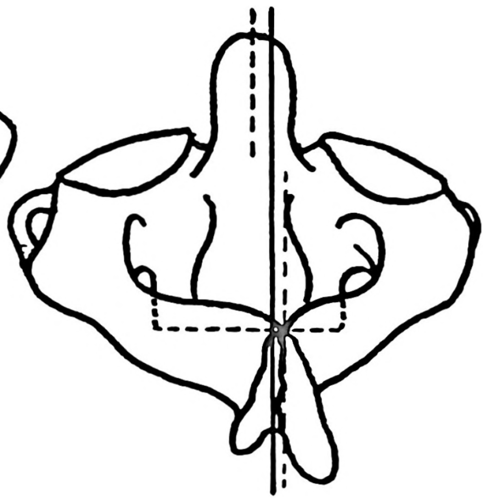
AXIS L-Center PIV. BODY SL.R.
Figure No. 112-R



AXIS L-Center PIV. BODY SL.R.
Figure No. 112-S



AXIS SL.R.-Center PIV.-BODY L.
Figure No. 112-T



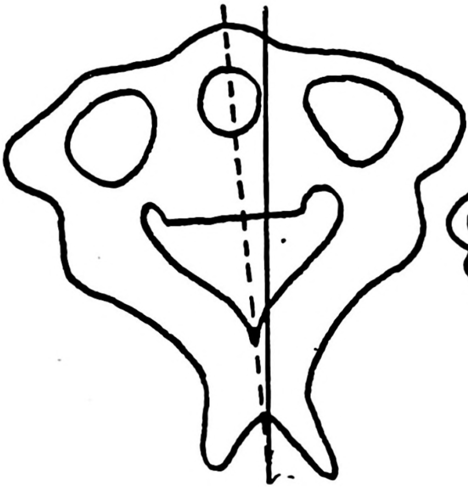
AXIS SL.R.-Center PIV.-BODY L.
Figure No. 112-U

thrust on the spinous might move the body more right or just rotate the body and only move the spinous toward the median line.

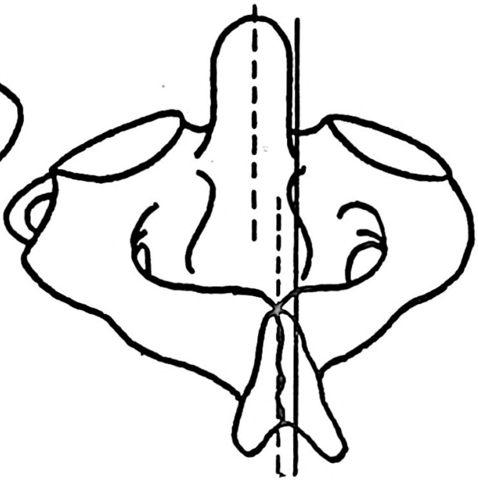
Figures 112-L and 112-M seem to present a common type of misalignment though perhaps not exactly as common as the axis, body pivot with or without body laterality. This listing is axis right, body pivot, body left. This is nearly the center pivot type. This demands still another type of adjustment, so to speak. These and Figures 112-T and 112-U are the only types of axis misalignment where rotary or Bench T.M. (if there is any merit to them) might work with some satisfaction. In this case force could be applied successfully on either the body on the side toward which it swings or on the side on which the spinous moves. These contacts would force the spinous toward the median line at the same time force the body toward the opposite direction and to the median line. Please realize that when using any of these twisting moves (rotary, Bench T.M. or even breaks) the leverage is often so great there is absolutely no control of the vertebra.

I would like to repeat that if you use rotary moves on axes, according to the laws of mechanics never use them on types other than those similar to Figures 112-L and 112-M, or 112-T and 112-U. I believe a recoil adjustment offers more control of the vertebra than these other moves because of the leverage in such contacts. If contact was made on the lamina near the pedicle on the side in which the body swings laterally low (left side in Figure 112-L and 112-M) the line of drive must have sufficient angle to move the spinous to the median line and at the same time move the body in an arch to the median line.

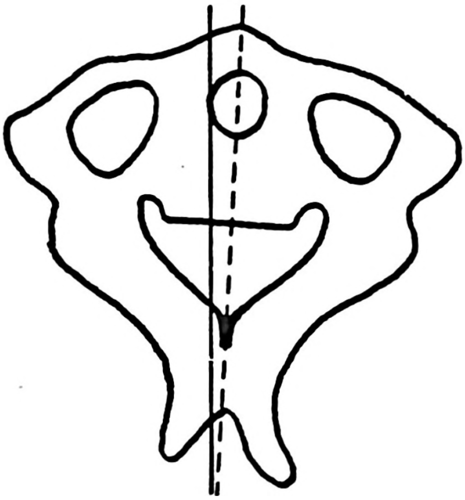
Figures 112-N and 112-O reveal no rotation of the body of axis but the entire vertebra having moved laterally right. In this case the spinous would not be listed because the spinous is in line with the center of its own body. Therefore the spinous alone should not be contacted and adjusted in this type of misalignment for it would produce body ro-



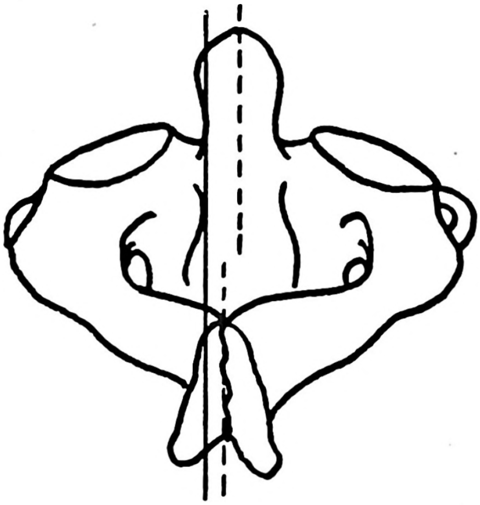
AXIS R-BODY PIV.—BODY L
SPINOUS L. OF MEDIAN LINE
Figure No. 112-V



AXIS R-BODY PIV.—BODY L
SPINOUS L. OF MEDIAN LINE
Figure No. 112-W



AXIS L—BODY PIV.—BODY R
SPINOUS R. OF MEDIAN LINE
Figure No. 112-X



AXIS L—BODY PIV.—BODY R
SPINOUS R. OF MEDIAN LINE
Figure No. 112-Y

tation and perhaps increase the condition of the body. The adjustic thrust must move the entire vertebra evenly toward the median line, using either a single pedicle or body contact with a particular line of drive or perhaps a double contact (nail point 1 and 2) on lamina as near to the body as possible. I would like to state that whatever mention is made of contacts and lines of drive it is strictly from the standpoint of mechanics and in accordance with the policy of our Technic Department.

Figures 112-P and 112-Q present an entirely different aspect. The listing would be spinous pivot, body left, and though the junction of laminae might be very slight right or left of the median line, the spinous should not be adjusted because the amount of leverage between the point of pivot and the possible point of spinous contact would not be sufficient to cause the odontoid to move back to the median line but instead the force would move the spinous away from the median line. This type calls for a lamina contact on the side toward which the body swings. In other words, if the body moves left in a spinous pivot the adjustment should be given on the left side and vice versa when the body moves right with spinous pivot. I am sure by now you agree that PR or PL means little until you know how axis moves to cause the spinous to move right or left of its own body.

Figures 112-R and 112-S—This is a center pivot, spinous left, body slightly right. Perhaps the contact could be made on either side but requiring a different angle in the line of drive. When a listing reveals just a plain center pivot, spinous and the odontoid the same distance opposite the median line, say 5 degrees, the line of drive might be five degrees more than a right angle to the posterior anterior line. Referring to Figures 112-R and 112-S, say the spinous moved five degrees left and the odontoid seven degrees right, the angle of drive could be seven degrees on the right or five degrees on the left.

Figures 112-T and 112-U—Axis listing is slightly right—

center pivot, body left. This means the spinous is listed slightly right because it is slightly right of its own body (body rotated left)—center pivot because spinous and odontoid moved opposite to the median line—body actually left because odontoid is closer to left condyle than just a center pivot would place it. Again a particular contact and line of drive is required. For this type it should be on the pedicle on the side in which the body moves laterally. The line of drive must be so the thrust moves the body in an arch and more than the spinous process.

Figures 112-V and 112-W—Axis right (spinous right of its own body) body pivot, body and spinous both left of the median line. In other words, this body moved far enough left to carry the spinous left of the median line, even though the body has rotated left with the spinous slightly right of its own body. Here the contact should be on the left side on lamina near pedicle with angle of drive sufficient and proper to move both the odontoid and spinous process to the median line.

Figures 112-X and 112-Y reveal the same as 112-V and 112-W except in the opposite direction.

Inability to make proper contacts may include either physical handicap of the chiropractor, such anomalies of patient preventing the usual contact, or it may include a physical condition of the patient preventing proper placement to make such contacts. Unfortunately some practitioners have hands so large that there are many atlas contacts they cannot make, yet the same contacts are made by others with a small hand.

I recall a recent incident where a chiropractor brought in a set of films for re-checking. I had previously read this set Atlas ASL, anterior; axis left, body right, and because the patient became worse after the first adjustment he naturally thought the listing was in error some way or other. He had established a 2 or 3 day NCM pattern, and after the second adjustment the pattern changed to a double left break. Of course I was aware the listing had

changed. I figured the adjustment moved the axis body farther right, causing the atlas to change from a left anterior transverse to a left posterior transverse. I convinced the chiropractor his contact had not been on atlas, but on the axis. We agreed to take another A to P view and learned the atlas was posterior left side, laterality remained nearly the same, axis spinous was right with body terrifically right. This listing was in accordance with the NCM pattern made just before taking the second spinograph. Axis was adjusted and the patient obtained immediate results. To my knowledge this case has not been adjusted since. What happened is that the original contact had been made on the axis and not on the atlas. I relate this case to promote caution and carefulness. This chap has said many times since that he would not accept a single case without first having sufficient spinographic views, then making a complete study of them before adjusting.

Be sure you familiarize yourself with the spinographs and decide whether you are able to make the desired contact, either physically or otherwise. One should not become too impatient if results are not as forthcoming as he thinks they should be. Remember there may have been a great deal of damage already done, in which event the patient may not always respond as quickly as others. Don't be too hasty about doing something else or adjust too often. If the patient receives the proper adjustment at the right time and he cooperates, results will be obtained.

CHAPTER 29

THE ATLAS

Figure Nos. 112-AA and 112-BB are normal views. Figure No. 112-AA indicates a superior view whereby observation is made thru the spinal canal, or neural ring, revealing the relation of certain descriptive parts with one another. Figure No. 112-BB is the anterior-posterior view showing the posterior aspect of the skull, atlas and axis.

The atlas is the first cervical or first vertebra of the spinal column. It supports the head and acts like a knuckle joint for the head to move on. It is the most peculiar segment of the spine because it is constructed different from any of the other vertebrae. It makes up the first neural ring which protects the upper portion of the medulla spinalis and the lower portion of the medulla oblongata. It is said to have the least number of muscular attachments and is referred to as the most freely moveable vertebra, yet it is often the most difficult to adjust.

The atlas together with the axis forms a sort of locking device, keeping one or the other limited in its travel, either forward, backward or laterally. The first neural ring is of considerable size, in fact it is larger than is required to actually accommodate the medulla spinalis; hence apparent laterality of the atlas may occur with little or no compression of this structure. Therefore a debatable question arises, namely, which of the two vertebrae (atlas or axis) is likely responsible for the most pressure made against the medulla spinalis?

The atlas like axis moves abnormally in several directions; also there are many directions in its subluxation to care for in the single adjustment. These directions, like those of axis, cannot be consistently palpated with any degree of accuracy. Therefore, the proper and complete spinographic views are not just a mere fad or matter of convenience, but an abso-

lute necessity. In other words, to practice atlas and axis specific, demands the proper and necessary spinographic views; otherwise it is unwise to even attempt to offer such a service. It is the writer's personal opinion that atlas or axis should never be adjusted without the aid of the proper spinographs. In the event of no spinographs, an adjustic thrust might relieve a direction in the subluxation and at the same time increase another. So why not offer a more scientific Chiropractic service by spinographing each case?

In addition to anteriority, superiority or inferiority, laterality and rotation, the atlas pivots. Some refer to this condition as a partially locked atlas. This condition appears quite frequently altho not as common as the axis pivot; however, neither have been generally understood.

When selecting a major, no doubt the highest point of manifestation should be first considered. However, it may be necessary to adjust the axis and then major on the atlas. The writer is convinced that in some cases muscular tension exists to the extent of retarding quick relief when adjusting atlas or axis. This is not intended as criticism of specific work, but merely a suggestion as one of the reasons why an occasional atlas or axis adjustment will not hold.

When listing the upper cervical films it is always advantageous to attempt to list the atlas rotation before its laterality, (and axis before listing atlas) for the reason that all these directions vary the width of the inter-odontoid spaces. For instance, the left lateral mass may extend into the foramen magnum more than the right. First thought then is a right atlas, but further consideration may prove the left lateral mass anterior in rotation with laterality left. In other words it is common to find a left atlas with the left lateral mass extending into the foramen magnum more than the right. Then too the left lateral mass might appear to overlap the left condyle, which on first thought might indicate a left atlas. But further consideration may prove that the over-lapping of the left lateral mass and condyle is the result of the left transverse moving anterior, though the

atlas may be slightly right. The left lateral mass overlapping the axis could be a left atlas, or it could be the result of the axis rotating right, or the body of the axis right. However, less difficulty will be had by listing axis first, then atlas rotation, before atlas laterality.

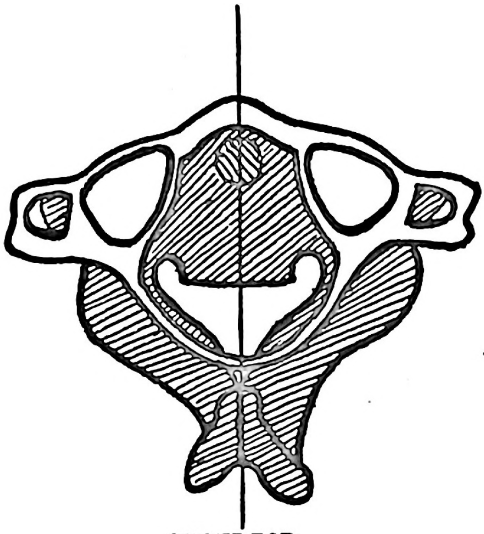
Figure No. 112-CC reveals a right atlas, right point wedge, atlas high right side, pivoted, right transverse posterior, left transverse anterior to a greater degree:—Axis right, body pivot, body right.

Note both the junction of laminae and body of axis are right of the median line, even though the axis is rotated left. The body is pivoted because the junction of laminae is right of the body, right of the center of the base of the odontoid, or rotated left. This is further indicated by the internal margin of the intervertebral foramen being larger on the right than on the left, the left transverse of axis is more prominent than the right, and the left zygapophysis is larger than the right. The body is right because the center of the base of the odontoïd is right of the median line.

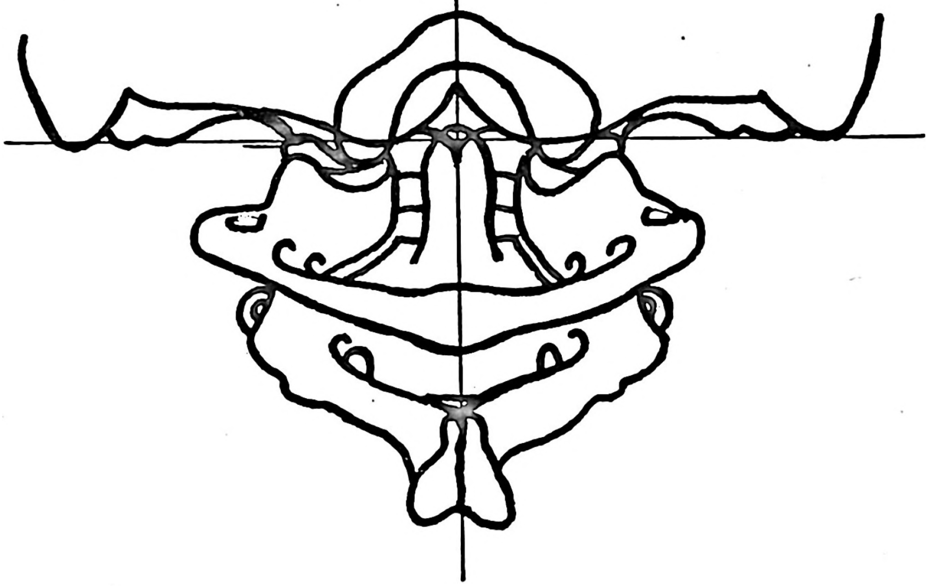
An adjustic thrust on the right side of the spinous would rotate the body and move the spinous towards the median line, but would not move the body in the same respect. From a mechanical standpoint the contact should be on the lamina, right side, near the pedicle with sufficient angle to the line of drive that the adjustic thrust would rotate the vertebra and at the same time force the body left, bringing the spinous or junction of laminae and the odontoid in the median line.

The atlas is pivoted, right transverse posterior, left transverse anterior to a greater degree. There are three very important factors to know when adjusting a pivoted atlas; first, the lateral mass and transverse opposite to the pivot point always moves forward, increasing the space between the odontoid and the anterior arch. Secondly, the axis of the rotation changes from the odontoid to the pivot point. Third, the amount of leverage is lessened, being from the pivot point to the point of contact, rather than from the

NORMAL VIEWS



SUPERIOR
Fig. No. 112-aa



ANTERIOR-POSTERIOR VIEW
Fig. No. 112-bb

odontoid to the point of contact as in the ordinary case. The laws of mechanics prove that sufficient leverage is necessary in an adjustment, otherwise the adjustic thrust would not correct the misalignment. To contact and adjust the atlas on the transverse on the side of pivot would in all probability tend to increase the anteriority; therefore, the contact in this case should be made on the side of atlas that swings anterior regardless of the laterality.

To determine the pivoted atlas, note the internal surfaces of the lateral masses. Here the left is much larger than the right. It naturally gets larger as it swings away or forward. To imagine a horizontal line across the internal surface of each lateral mass would reveal a much greater angle on the left relative to a posterior anterior median line than between this median line and the internal surface of the right mass. In other words, the posterior and anterior superior points of the right lateral mass are nearly in line from a posterior point of view; while on the anterior side of the rotation these points of lateral mass are separated or farther apart. This is an important factor proving the anterior transverse moves to a greater degree anterior than the opposite side moves posterior.

Further points indicating the left lateral mass anterior are the left transverse process shorter and greater in depth, the posterior arch larger on the left side with the tubercle slightly right of the median line, and the lateral inferior tip of the left lateral mass smaller than that portion of the right lateral mass. Another indication is the space between the condyles and the superior posterior margin of the lateral masses. On the left the space is smaller because the left lateral mass tends to move underneath the condyle and farther into the foramen magnum area as it moves anterior in rotation, naturally the posterior lateral mass moves out from underneath the condyle making the space wider on the posterior side of atlas rotation, also it tends to move out of the foramen magnum area.

Knowing the position of the axis in this case with the

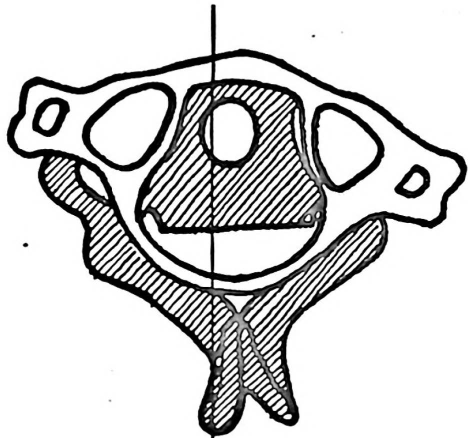
median line and that the atlas is pivoted left transverse anterior to a greater degree than right transverse posterior, it should not be difficult to determine the laterality of atlas.

Wedge lines make a right point wedge, so the first indication is a right atlas. Further, the atlas favors the right side of the skull, being closer to the right mastoid process than the left, and if the jaw was visible it would be closer to the right side of the mandible. The left lateral mass extends into the foramen magnum more than the right, but of course the left transverse is anterior to a greater degree. The interodontoid spaces vary, the right being much wider.

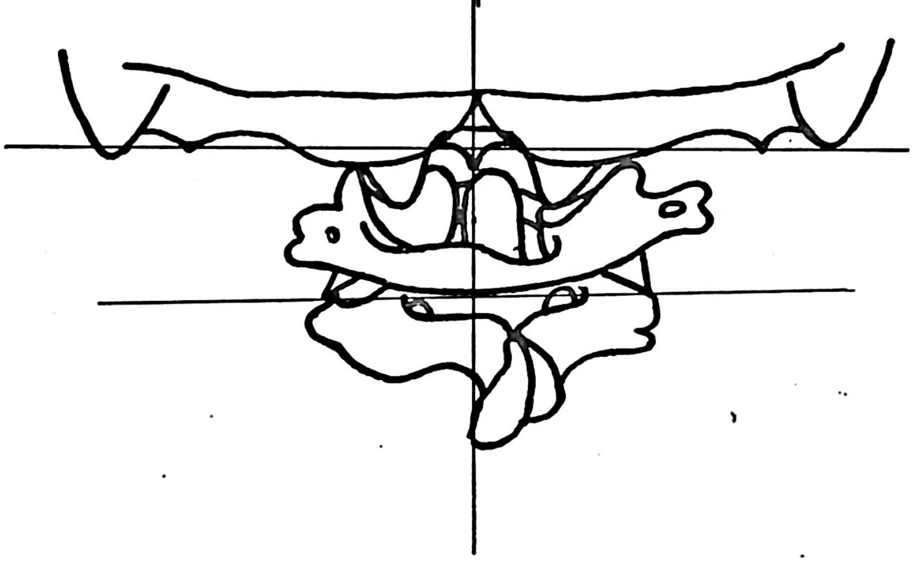
Remember that the body of axis is right with the odontoid in close proximity to the right condyle. With the ordinary atlas this position of axis would make the right interodontoid space narrower than the left. The atlas rotating anterior on the left to a greater degree, plus the sideslip right, has caused the left lateral mass to appear close to the odontoid. The odontoid being closer to right condyle than the left and the left lateral mass nearly obliterating the left interodontoid space, proves the atlas has sideslipped right.

Comparing the internal margins of the first and second neural rings as indicated by this superior view, (Fig. No. 112-CC) one will note that the internal surface, left side of axis (second neural ring) is closer to the median line than the same portion of this ring on the opposite side.

Had not the atlas moved in opposite direction to axis and remained in a nearly normal position, we assume the only pressure to be found in the canal in this area would be from the left side of axis. But this view indicates the atlas has rotated in opposite directions to axis, causing the internal right posterior aspect of the posterior arch to have misaligned with axis on the right side, indicating probable pressure at this point. In other words, it appears that a double Neurocalometer reading would occur in a case of similar misalignment, viz., a left reading at axis due to the body having moved right, and a left reading at atlas because of the pivot and increased anteriority.



SUPERIOR VIEW



ANTERIOR-POSTERIOR VIEW

Fig.No. 112-cc

Fig. 112-DD reveals a left atlas, left point wedge, atlas high left side, pivoted, left transverse posterior — right transverse anterior to a greater degree: — axis left, slight body pivot, body very slightly right.

The junction of the laminae of the spinous process of axis, as well as the spinous process itself are left of its own body, left of the median line, which means the body is rotated right. The body is slightly right because the center of the base or a greater part of the odontoid is right of the median line. This particular pivot of the body of the axis is nearly a center pivot inasmuch as the junction of the laminae is only slightly more to the left than the odontoid is right of the median line. In other words, in a center pivot these two descriptive parts should be the same distance to the median line. Further proof that the body of axis is rotated right, with spinous left of its own body, is the intervertebral foramen, which is only visible on the left side. Also the right zygapophysis appears larger. All of this is the result of the right side of axis rotated posterior.

The adjustic thrust should be from the left as far posterior as possible on the spinous process so as to rotate the vertebra without moving the body laterally, placing the spinous process in the median line.

The atlas is pivoted with left transverse posterior, right transverse anterior to a greater degree. Points proving right transverse anterior in rotation are the internal surface of right lateral mass larger than the left, right transverse shorter and wider with transversarium foramen partially obliterated by its lateral mass, right side of the posterior arch larger, the lateral inferior tip of right lateral mass or that part of the lateral mass extending below the posterior arch is smaller than that part of the left lateral mass. The space between condyle and right lateral mass is not as great from a posterior aspect as the same space on the posterior side of atlas rotation. This is because the right lateral mass tends to move underneath the right condyle as the right side of atlas moves anterior in rotation. The right lateral mass

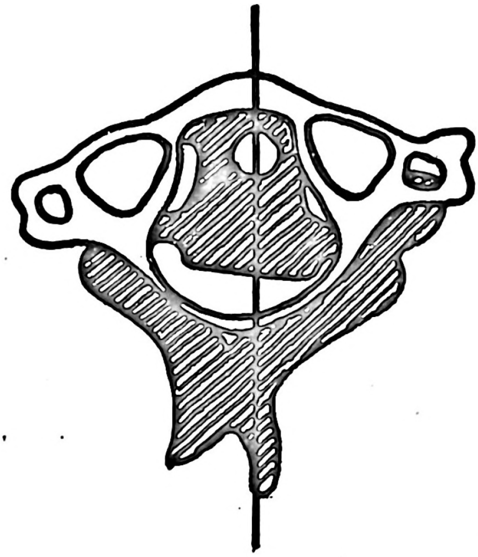
extends into the foramen magnum area more than the left, but this is also due to the left laterality.

Points favoring the atlas pivot are the internal surfaces of lateral masses and the amount of the articulation of the anterior arch visible thru the left interodontoid space. If the axis of atlas rotation was at the odontoid with right transverse anterior—left transverse posterior (no anomaly) the internal surface of the left lateral mass would only appear half as large as the right. But when the right transverse rotates anterior to a greater degree than the left, the internal surface of the left lateral mass will still appear smaller than in the first instance. The fovea dentalis articulation of the anterior arch in this case has moved left and away from the odontoid as the right lateral mass and transverse move anterior in rotation. Incidentally, this creates greater space between the odontoid and the anterior arch thereby increasing anteriority. This is seen thru the left interodontoid space, but of course it is exaggerated by the left sideslip of atlas.

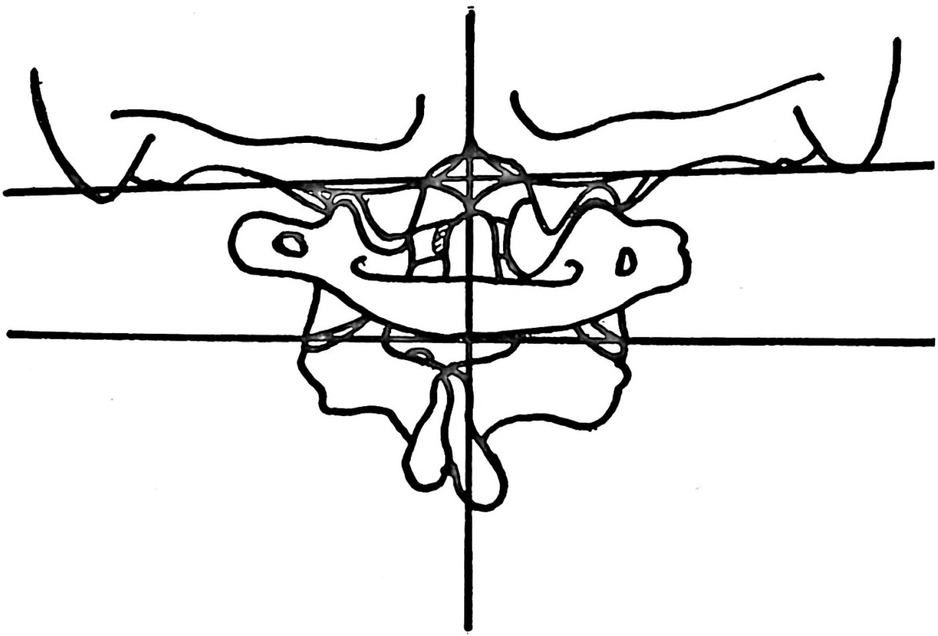
To contact and adjust this type of atlas rotation on the side of laterality would in all probability tend to force the left side of atlas anterior rather than force the right side posterior towards a normal position. Again, the reason is insufficient leverage. This contact should be on the right side.

Plane lines make left point wedge, the first indication of atlas laterality or sideslip. Further checking, the atlas is high on the left side indicating it has moved up on the left condyle as it sideslipped left. The left lateral mass is nearly out of the foramen magnum, while the right is decidedly in, but this is partially due to atlas rotation and pivot.

The length of articulating surface between condyles and lateral masses appears longer on the left side, which is another indication of a left atlas. This, however, is varied by the posterior or anterior rotation. The left interdontoid space is greater in width than the right, and this is also partially the result of atlas rotation and pivot. Again may I repeat



SUPERIOR VIEW



ANTERIOR-POSTERIOR VIEW

Fig.No. 112-dd

that less difficulty is found in film analyses when first reading the axis, then the rotation of atlas and then atlas laterality or sideslip.

Fig. No. 112-DD superior view, reveals atlas and axis rotated in opposite directions. Comparing the internal margins of these neural rings, the right posterior aspect of both vertebrae is closer to the median line than the left side is to the median line. Because the axis is pivoted with the odontoid nearly in the median line and atlas pivoted with the right transverse anterior to a greater degree, it has caused the first neural ring to appear slightly anterior to the second neural ring at this point on the right side. The atlas left, and a slight degree of posterior rotation left side, has kept the internal left side of these rings nearly in line. So in a similar case if pressure exists we could assume it would be at the atlas on the right side.

CHAPTER 30

SUMMARIZING THE COMPLETE SET OF TEN FILMS (TWO FLATS AND FOUR SETS OF STEREOS) AS THEY COMPARE WITH ONE ANOTHER

The Necessity of Precision Alignment in Listing the Atlas Subluxation—It is now certain that the atlas rotates and the opinion is this causes more damage than the actual side-slipping. Before attempting to determine atlas rotation, it is first essential to know the normal, then to study the abnormal and to know certain factors present in the actual production of the negative.

This procedure requires the use of the X-ray machine, a vertical cassette holder, an 8 x 10 bucky diaphragm and a turntable, with or without a track. If operating without the track the cassette holder should be bolted to the floor and the X-ray machine made to line up with the cassette holder. To operate on a track, the machine becomes a constant. Precision equipment promotes perfect alignment and increases results.

It is obvious that cervical placement in spinographic stereoscopic procedure is composed of one constant and six variable factors. This is exclusive of the machine technicalities.

When retakes, particularly comparative sets are taken, these points must be considered and charted so as to know how additional film sets compare with the first set in spinal subluxations, misalignments, and spinal contours. This points out whether or not there have been any definite changes in relative positions of the vertebrae, before and after adjustments.

Points in placement are as follows:

1. Align the two points of the skull—A constant.
2. Turn table (for rotating patient's entire body)—A variable.

3. Lateral seat travel—A variable.
4. Forward and backward seat travel—A variable.
5. Angle of bucky and tube—A variable.
6. Height of bucky and tube from the floor—A variable.
7. Consideration of patient's visibility (whether ocular disability allows him to hold head in alignment with direct vision)—A variable.
8. Points of machine technicalities and darkroom are as follows:
   a. Kilovolt peak—A variable.
   b. Milliamperes—Constant.
   c. Tube distance—Constant.
   d. Milliampere seconds—Constant.
   e. Developing time—A constant. Six minutes, (with temperature approximately 68 degrees Fahrenheit).

Placement — In order to arrive at a definite conclusion in spinographic film analysis, it is very important that placement of the patient and the tube be properly made. The tube and film should be on the same parallel plane. The tube should direct its central beam of rays at right angles to the film. The occipital protuberance and frontal groove should be in line with one another as well as in line with the direct path of X-rays.

When analyzing the film to know the abnormal position of the head in placement, consideration is first made of the occipital protuberance, relative to the imaginary median line vertically through the foramen magnum. If the occipital protuberance does not correspond with the median line either because the head is abnormally rotated or the film and tube are not in proper alignment, one of two things will happen.

First the abnormal rotation was not removed in placement so to speak. The result—the occipital protuberance appears right or left of the median line. In this event, the mastoid on the anterior side of the head rotation will appear

larger in area and have little or no contrast, and fuzzy outlines.

Further proof of this is to imagine three vertical lines, one through the occipital protuberance and one at either lateral side of the mastoid processes. You will note that the distance from the center line to the line of the anterior mastoid is greater than that from the center line to the line of the posterior mastoid, etc.

Note the relative position of the nasal spine and occipital protuberance. As the occipital protuberance is right, a greater amount of nasal spine will be seen left of the median line. Further note the relative position of the superior teeth contour to the foramen magnum area, and also the upper incisor teeth relative to the occipital protuberance.

Secondly, an anomalous or malformed occipital protuberance. To know this, the occipital protuberance will appear right or left of the median line but the mastoid processes will appear the same size having the same density. The nasal spine will line up with the median line. The upper teeth will assume their natural position relative to the foramen magnum, as well as the ramus.

In a hypothetical case with the head rotated, revealing the occipital protuberance right of the median line, the following characteristics should be apparent: the right mastoid will appear larger and less contrasting. The right half of the superior teeth will appear more into the foramen magnum area; the nasal spine center will appear more left of the occipital protuberance. The angle of jaw on anterior side of head rotation will appear larger, width of jaw wider, and internal rim of jaw closer to upper molar teeth, unless teeth on that side are missing, etc. Then the atlas will take on the appearance of a right anterior transverse, and the spinous process of axis will undoubtedly be found right of the median line—unless an exaggerated right rotation of axis is actually prevalent.

The sitting upright posture and the standing position are more valuable than the supine, because the patient's cerv-

icals must be viewed when the patient is in a normal, relaxed position. This is all very difficult and more or less incorrect in supine postures.

The sitting posture is further advocated for the simple reason that the patient can ordinarily be kept motionless without any difficulty during the exposure, as compared with the standing position. Bear in mind, that this is most important, particularly so in stereoscopic exposures, inasmuch as motion, on either stereoscopic view, will not permit the two films to fuse. This naturally interferes when attempting to analyze the films.

Head clamps and often compression bands are used for immobilization. These, together with instantaneous exposures, will further aid in eliminating motion on the film. Always place a cork in the patient's mouth between the teeth to decrease resistance to the X-rays, and to eliminate any overshadowing by teeth. A rotation of the body is usually necessary when properly aligning the patient to get these points of the skull parallel with, and in line with the direct rays. This amount of rotation usually ranges from two to seven degrees, and should be remembered when making the analysis.

Alignment — To obtain an unobstructed view of both anterior and posterior portions of the foramen magnum, condyles, lateral masses, transverse processes, posterior arch, axis and its odontoid, spinous processes, all of which should be seen between the upper and lower teeth on the film, precision methods must be used. The tube must be in perfect alignment with the cassette, directing its rays absolutely at right angles to the film. An ideal method in producing such an alignment is the use of proper levels to determine when the film and the tube are on the same parallel plane. A string is attached to the tube casting or arm, indicating the focal point of the tube target. To operate the string, the loose end is placed against the patient's occiput, in such a manner indicating that the X-rays are properly directed. String should be kept taut against the side of the patient's face and the

patient's mouth should be wide open when making this alignment, as well as during the exposure. The exception to this rule of string alignment could only be due to anomalies, malformations, gold crowns, or bridge work in the patient's mouth and then only a slight variance is used in the tube alignment to maintain the least amount of distortion and elongation. In other words it is advisable to vary slightly the angulation of rays rather than to change the position of the patient's head for cervical X-ray work.

Stereoscopic AP, Vertex and Diagonal Work—In this work the tube separation is 2½″ at a tube distance of 30″. For a 36″ tube distance the tube is shifted 1½″ each way of the median line, making a total of 3″ at 36″. At a 42″ tube distance the tube is shifted 1¾″ each way of the median line or 3½″ tube separation. An additional 1″ tube separation is allowed for every 12″ increase in the tube distance or a ratio of 1″ per foot. The tube and the film are constant factors.

OBSERVE THAT BOTH CASSETTES ARE PLACED IN AN IDENTICAL POSITION FOR THE DIFFERENT TUBE SHIFTS, WITH THE LETTER R IN THE MARKER ON THE CASSETTE AT THE PATIENT'S RIGHT SIDE. THIS INDICATES THE RIGHT TUBE SHIFT. THE LETTER L IN THE MARKER ON THE CASSETTE, AT THE PATIENT'S RIGHT SIDE, INDICATES THE LEFT TUBE SHIFT. THIS PARTICULARLY REFERS TO THE AP VIEWS.

Diagonal Stereoscopic Views — Diagonal stereos are likewise important. They are made by rotating the patient, with no exertion on his part whatever, from a true lateral position to a diagonal one of 35 to 45 degrees towards the X-ray tube. The amount of rotation made is correctly indicated by the graduation on the turntable. Markers with this type of stereo identification are again placed on the film, but according to the operator's right and left side as he (the operator) faces the back of the cassette. This, in reality, is

the patient's right side if the rays are directed from left to right.

The film may be placed against the right or left shoulder, according to the manner in which the operator conveniently proceeds. Both exposures are made from only the one side.

Placing the Films in the Stereoscope for Interpretation — Ordinarily the film marked R is placed in the left stereo box with the marker towards you and the film marker L goes in the right box with the marker away from you. But when vertex stereo films are made directing the rays from posterior to anterior, the procedure of placing the films in the stereoscope is changed. In this case, the right film goes in the right box with the marker towards you, and the left film goes in the left box with the marker away from you. In this event, you view the case beneath the chin looking at the anterior side of the bodies. What would be the patient's right side would be your left and what would be the patient's left side would be your right.

If placing the PA vertex stereo films in the stereoscope with the right film in the right box with the marker away from you and the left film in the left box with the marker towards you, you would read the film from the posterior. What would be your right would be the patient's right side and what would be the patient's left side would be your left.

When reading AP vertex stereo films, the films are placed in the stereoscope as of the ordinary AP or diagonal stereos.

Then in either case the two films are horizontally leveled by manipulating the stereo mirrors and fused ready for reading.

Before considering the interpretation of the atlas subluxation, a brief review of the Atlas-Axis Specific work spinographically will be given.

Stereoscopic Sets — The complete set consists of ten 8 x 10 films as follows: the Lateral and AP flat, AP stereo, diagonal stereo, vertex stereos either AP or PA views, and the nasium stereo. These ten films make a complete stereo-

scopic spinographic set. In problem or border-line cases the use of ten films offers more information and will surely enable one to make the adjustment.

The two flat or natural films are not ordinarily sufficient to reach a definite conclusion as to the four directions in atlas subluxation. Only certain points are brought out here. However, in the ordinary case one may not have any difficulty in reading the first three directions from these flat films.

Laterals are made from a true lateral position of either side of the patient while AP views are made in the same cautious manner and as the name indicates, they are taken from anterior to posterior. Remember in flat work the various descriptive parts are seen like a mass piled only in front of one another. Rarely is any indication of depth or third dimension revealed. Third dimension is only produced, spinographically, in stereoscopic procedures.

Lateral Natural to determine:

1. The apparent amount of anteriority, determined by the amount of space revealed between the anterior ring and odontoid process of axis, of course considering the PI axis. This space usually appears dark on the film. It is the first direction in an atlas subluxation and is always more or less present.
2. Superiority or Inferiority is the position of the anterior ring of the atlas at its anterior and is determined by drawing a plane line on the film from the center of the anterior ring back through the center of the tubercle of the posterior arch. When this plane line points upward at the anterior the atlas is considered superior. A level atlas is considered inferior. Incidentally, an atlas may be superior or inferior and its transverse processes may be found tilting upward or downward on the side of laterality. The thought being conveyed here is that a palpated superior or inferior transverse of atlas does not necessarily mean a superior or inferior

atlas. **TO SPINOGRAPH EVERY CASE IS THE CORRECT WAY TO PROCEED.**

Inferiority is determined in the same manner, so far as drawing the plane line is concerned, for when the line points downward at its anterior it is said to be inferior. Superiority or inferiority is the second direction in the atlas subluxation. Superior atlases are far in the majority.

3. Posterior-Inferior axis is determined by the posterior, inferior tipping of the axis, relative to the third cervical, the cervical spinous process compression, the wedge-shaped space between zygapophyses of axis and third cervical, and also the intervertebral disc space between axis and third cervical. The posterior border of the bodies of the cervical vertebrae appear as a light to white line on the film. Such lines of this entire region form an arc, and are plainly visible. If the axis is actually posterior-inferior this white line of axis breaks the continuity of the arc and assumes a different angle.
4. Contour refers to the shape of the vertebrae as well as to the entire region.
5. Lordosis or kyphosis refers to the posterior or anterior abnormal bending of a spinal region.
6. Exostosis or ankylosis refers to an outgrowth of osseous structure and the fusing of two or more segments, respectively.
7. Anomalies and malformations refer to changes in the development of the segment and its descriptive parts, from an anatomical view. Anomalies or malformations may be congenital conditions such as incompleteness of structures, or they may be the result of fractures dislocations, etc.

AP Natural to determine:

1. Location of the occipital protuberance. To know the position of the occipital protuberance, relative to the

median line, is absolutely essential in determining the point of wedge, particularly when listing an atlas transverse as being anterior or posterior. The median line is that vertical imaginary plane line extending through the center of the foramen magnum, at right angles to the horizontal plane line of condyles. This position may not coincide with the anatomical location, due either to an anomaly, or the head being rotated in the placement relative to the path of X-rays. Such an abnormal position of this part on the film may cause erroneous listings. If an anomaly existed and the occipital protuberance was found right of the median line on the film there may or may not be any rotation of the head, relative to the central beam of X-rays. If no anomaly of this part exists and the protuberance is right of the median line then there is, so to speak, an abnormal rotation of head in placement. To determine the rotation of the head, note the size and density of the mastoid processes, as well as the size of the upper portion of both rami, the angle of jaw, etc.

2. Jugular processes appear on the film as a sort of lip extending down from the occiput or they may be somewhat round in shape. They are located between the mastoids and the lateral masses of atlas, and usually appear over the tip of the transverse processes of the atlas. It is from these two points that the superior wedge line is drawn.
3. Superior wedge line — This line refers to the position of the occiput on the side of the point of wedge.
4. Inferior wedge line. The inferior plane line completes the wedge. It is drawn from the very lateral inferior tip of the lateral mass across, to the same point on the opposite side.
5. Point of wedge refers to the least amount of space between the above two lines at their lateral extremity. This is indicative of the direction in which the atlas side-slips. As the atlas moves laterally it moves up on

the condyle, therefore the point of wedge. All subluxated atlases acquire laterality and rotation to some degree. This in turn produces a point of wedge in the direction in which the atlas side-slips. The rule is:

THE ATLAS ALWAYS SIDE-SLIPS TOWARDS THE POINT OF THE WEDGE UNLESS THE WEDGE LINES ARE ERRONEOUSLY DRAWN, EITHER BECAUSE OF CARELESSNESS, POOR VISION, OR MALFORMATIONS. LATERALITY IS THE THIRD DIRECTION IN ATLAS SUBLUXATION.

6. Position of occiput at side of point of wedge: The reason for knowing the position of occiput or condyle at the side of laterality is that the atlas should never be adjusted into the point of wedge unless the wedge is erroneous due to malformation. It is the opinion that such would ordinarily increase the point of wedge rather than decrease it. The occiput may be either high or low on the side of atlas laterality. According to records on file, the majority are low.
7. Laterality of axis refers to the position of its spinous process, relative to its own body.
8. Contour refers to the shape of the vertebra, as well as the entire region.
9. Cervical region rotation refers to the rotation of three or more adjacent segments rotated in the same direction.
10. Lateral cervical bending refers to the position of the spinous processes of three or more adjacent vertebrae, relative to the convexity or concavity of the cervical bending. In a right or left scoliosis the spinous processes follow the convexity of the curvature. In a rotatory scoliosis the spinous processes follow the concavity of the curvature.
11. Anomalies and malformations, same as for lateral except from other angles, etc.

AP Stereo Films: (two in number)

They are two in number, right and left (two films of one side only). With the correct technic and by properly placing the films in the stereoscope they may be made to fuse, revealing depth and third dimension. This depth proves the fourth direction in atlas subluxation. There seems to be no end as to what one may see in stereoscopic reading; how plain are the neural rings and the various cavities through out; the posterior tubercle, with its occasional incompleteness of the posterior arch; the transverse processes of the atlas in their positions, far from or near the film; the pivot or laterality of the spinous process or the body of axis and the anomalies and malformations not clearly visible under ordinary flat or natural work.

Though the foramen magnum and the length of the articulating spaces, between the condyles and superior atlas articulations on both right and left sides are of some value in verifying the point of the wedge, too much dependency should not be exercised in this respect unless due consideration is given to anomalies and atlas rotation. For example: Anatomically, the lateral masses evenly divide themselves within the foramen magnum area on the film. As the atlas side-slips to the right, naturally the tendency is that the right lateral mass moves laterally out of this area and the left in, and vice versa, when considering a left side-slip. We know that the atlas rotates with the axis, or in the opposite direction. A right side-slip will reveal, on the film, a portion of the anterior margin of the lateral mass either within the foramen magnum area or entirely out, as the case may be. In other words, in a right side-slip of the atlas with a right transverse anterior, the anterior internal portion of the right lateral mass will appear on the film within the foramen magnum area while the posterior right transverse of the same portion of the lateral mass may appear out of the area. So it is understood that a right side-slip of the atlas may reveal the transverse process within or out of the foramen magnum. Ordinarily when the right transverse is

anterior the left is posterior. Occasionally the atlas appears to pivot and that seems only when the point of the wedge and the anteriority or space between the odontoid and anterior ring is exaggerated.

Please remember that when the anterior or posterior transverse processes are mentioned, in no way is reference being made to the space between the anterior ring and the odontoid, only to the rotation of the atlas.

The following points, with proper deductions, will tend to prove the rotated atlas. These points favor the posterior right transverse: The opposite should prove the anterior right transverse.

1. Position of posterior tubercle, ordinarily left of median line.
2. Right transverse appears longer, narrower, more clearly outlined, not overshadowed by right lateral mass.
3. Transversarium foramen smaller, yet true in circumference and well outlined. (Ordinarily not overshadowed by the lateral mass).
4. Right lateral mass smaller, but more clearly defined.
5. Darkened area of internal right lateral mass, that part adjacent to the inter-odontoid space, smaller.
6. Tubercle for attachment of the transverse ligament, (when visible) more clearly profiled, and its area more or less dark.
7. Groove for the first pair of spinal nerves and vertebral artery more clearly outlined, its shape or form appearing nearly normal with less overshadowing of the posterior arch.
8. Portion of the lateral mass appearing inferior to the posterior arch larger.
9. Apparent size, shape, and position of the first neural ring, relative to the posterior portion of the body of the axis. More of the superior portion of the body and superior articulation of axis will be seen superior to the posterior arch on the side corresponding with the an-

terior transverse of atlas than on the other side. (Anterior tipping of axis must be considered as well as rotation).

10. Inter-odontoid spaces will vary with sideslip or laterality and rotation of both atlas and axis.
11. Lateral over-lapping of the lateral masses, relative to the superior axis articulations.
12. Lateral over-lapping of the superior portion of the lateral masses and condyles.
13. Outer margin of the anterior half of the fovea dentalis articulation and the odontoid process is often visible when an atlas transverse is posterior on its side of laterality.
14. Distance from the posterior tubercle to the outer edge of lateral masses will be greater, in favor of the posterior transverse.
15. When a posterior atlas rotation is slight on side of laterality and the point of wedge and anteriority is exaggerated, the posterior tubercle may be found on the side of median line corresponding with the point of the wedge.

There are perhaps other insignificant points too numerous to mention.

Diagonal Stereo — (Two in number)

The ever increasing appearance of the anomalies and malformations on spinographic films necessitated other views to verify, check, and prove atlas subluxations. So the diagonal views were made and found valuable. The following points mentioned in diagonal work are in favor of a right posterior transverse. The contradiction would apply to the opposite or anterior transverse. There are five factors to consider before attempting to read diagonal stereos:

1. At which side of patient the film was placed.
2. From what angle visualization is being made.
3. Whether or not there is any rotation of the axis.

4. The point of wedge.
5. What anomalies and malformations were revealed from the AP views.

The following points are based on a 35 degree angle with patient rotated from a true lateral position to one of 35 degrees towards the tube and with the film at the patient's right shoulder:

1. Assuming no anomalies or malformations are present, the posterior inferior margin of the right lateral mass will extend posterior to the superior posterior margin of the superior right axis articulation.
2. The right lateral mass will have more or less completely overshadowed the odontoid.
3. The left lateral mass may be overshadowed somewhat by the odontoid of the axis.
4. The right transverse appears larger, with its tip end more or less visible.
5. The transversarium foramen will have moved posterior to that point of the axis.
6. An imaginary vertical line, bisecting the groove for the first pair of spinal nerves and vertebral artery will be found located on the film posterior to the same sort of imaginary line through the pedicles of the axis.
7. The spinal groove of posterior arch appears more true to form.
8. The superior posterior portion of the space, between the left condyle and the left lateral mass, decreases while the same area of the opposite condyle and lateral mass increases on the film.
9. A posterior-superior point of the right lateral mass will be found posterior to the condyle above.
10. A posterior-superior point of the left lateral mass appears to move diagonally anterior to the condyle above.
11. Ordinarily the left transverse process is not visible. Should it be, then only a small amount of the tip is in view. This depends upon the degree of atlas rotation.

12. That portion of anterior arch adjoining the left lateral mass is also overshadowed by the odontoid.
13. The wedge-shaped space formed on either lateral side of the odontoid by the fovea dentalis articulation of the anterior arch decreases its appearance as the transverse process moves posterior.
14. The amount of space or dark shadow, revealed between the odontoid and the center of the articulating surface of the anterior arch, is the approximate amount of anteriority of atlas or the first direction in atlas subluxation.

Incidentally in a lateral view if the idea of the marker is generally carried out one may readily know at which side of the patient observation is being made. When the anterior arch of the atlas points towards the marker, observation is being made from the right side of the patient. When the spinous processes point towards the marker, observation is being made of the left side of the patient.

It is understood that the rotating of the axis in diagonal reading may give one an erroneous idea of the rotation of atlas. With a normal atlas and axis and practically no anomalies and malformations existing the anterior edges of the body of axis line up with the lateral masses of atlas. No rotation of atlas and a right rotation of axis reveals the right lateral mass projecting anterior to the body of the axis or the superior axis articulation. When the atlas rotates right, such appearances are reversed.

Remember, determine the rotation of the axis, if any, before attempting to determine the rotation of the atlas in diagonal views.

Vertex Stereos: (two in number)

Further consideration of the anomalies and malformations found in our daily routine, particularly in border-line cases, has caused investigation, research and experimentation promoting another view to be taken stereoscopically and diagonally through the foramen magnum, first and second

neural rings. This is known as the vertex view. Precision in procedure is absolutely carried out; distortion so far as elongation is concerned, is minute.

There are many ideas as to which placement is the best for vertex stereos. Some advocate the supine posture, allowing the head to tilt back, elevating the chin, and directing the rays diagonally downward from the anterior. Others use the sitting upright posture. The latter is no doubt the correct posture because the patient is not only more relaxed but elevation of the chin is not ordinarily necessary. Should elevation of the patient's chin be essential it would only be of a slight degree. Too much elevation of the patient's chin causes distortion. There is a variance in the actual spaces between the occiput, the posterior arch of atlas, and the posterior arch and spinous of axis. This would not only cause difficulty in making the analysis but would perhaps cause one to make an incorrect listing.

For sitting upright posture there are two ways that one may proceed in placing the film for vertex views. Place the film at the posterior, direct the rays upward from the anterior. The other method is to place the film at the anterior and direct the rays from the posterior diagonally downward. When directing the rays from the posterior, with the film at the anterior the film may or may not be on a parallel plane with the tube; but when directing the rays from the anterior the film and tube are on the same parallel plane.

This type of film should reveal the location of the frontal groove; the nasal spine, the rami, the basilar processes, the general inferior position of atlas and condyles, the ôdontoid, a faint outline of the body of axis, with first and second neural rings visible as well as the occipital protuberance clearly outlined.

In placing the P to A vertex films in the stereoscope, the one marked R goes in the right box with the marker towards you, and the other marked L goes in the left box, with the marker away from you. They are fused like the ordinary

stereos. The interpreter will see the marker at his left side, which in reality is the patient's right side; the chin will point towards you, while the occiput is away from you. By reversing these P.A· films in their respective boxes, (R. in right box, marker away; L. in left box marker towards you) you will see marker at your right the same as any anterior posterior view. Remember if A to P views are made, they are placed in the stereo boxes like other ordinary A to P stereo films.

In reading this type of film, first form an imaginary vertical plane line extending from the frontal groove down through and parallel with, the nasal spine, through the basilar process and foramen magnum, in line with the occipital protuberance. Then form an imaginary, horizontal plane line through the atlas bisecting the transversarium foramen. Anatomically, these two lines should appear at right angles, providing anomalies and malformations do not exist, and when precision is carried out. When a rotation of the atlas exists, these lines are not at right angles. When the entire atlas shifts laterally, towards the point of jaw, it is indicative of atlas laterality. When the atlas rotates with one transverse moving superior, it signifies the anterior transverse; but when a transverse process is seen lower than the other it is obviously the posterior one.

With the axis normal, so far as anterior posterior tipping is concerned, one may get an idea of the amount of anteriority revealed by this type of film. This is seen by the black space on the film, between the anterior ring and odontoid of axis.

This type of work is always carried on in the same precision-like manner, with absolute caution for the safety of all patients.

Nasium Stereo (2 films)

Because of anomalies and malformations a further check to verify information obtained from other films is made by taking nasium stereos. Placement is the same as AP with the mouth kept closed. An imaginary plane line bisecting a point just inferior to the frontal groove and the point of the chin, should be parallel with the film or as nearly so as possible, taking into consideration that placement of the skull is to be made without manually moving the head. The central ray is directed through the nose in line with the base of the occiput so that it strikes the film near its center. In viewing the film one should see the atlas above the superior teeth through the ethmoid and sphenoid bones. The condyles, jugular processes, odontoid of axis and the anterior foramen magnum area should also be visible.

Since this view is made through the nasal area large amounts of skull structure appear on the film making it a difficult procedure for the average individual to observe all the descriptive structures, therefore it is more advantageous to make the nasium stereo and obtain the necessary depth to correctly visualize the film.

All points should be considered. Add points in favor of and against, then make deductions before any definite conclusion is reached.

CHAPTER 31

THE NORMAL AND ABNORMAL SPINE

The author is in no way attempting to plagiarize from the text of Dr. J. H. Craven's work in orthopedy and abnormalities, but rather to mention, for clarity's sake, factors in parts of the two subjects. But he considers that the following pages would present certain anatomical knowledge that chiropractic spinographic technicians should have.

The spinal column is flexible and located in the posterior medial line of the body. In the child it consists of thirty-three moveable segments; the sacrum includes five and the coccyx four. But in the adult there are twenty-six segments in the spinal column of which the sacrum is one and the coccyx is one. Ossification of the latter two takes place about the age of puberty. The spine consists of only twenty-four segments and these are known as true moveable segments or true vertebrae while the sacrum and coccyx of the adult are known as false vertebrae; so actually the spinal column is made up of twenty-four true vertebrae and two false.

The length of the male spine is approximately twenty-three inches while that of the female is about three inches shorter. The spinal column is from twenty-seven and one-half inches to twenty-eight inches long.

Anatomically there are seven cervicals, twelve dorsals, five lumbars, one sacrum and one coccyx.

The length of the cervical region is approximately five inches, the dorsal, eleven inches, the lumbar region, seven inches, and the sacrum and coccyx, five and three-fourths inches.

In early life the spinal column assumes two primary and two secondary curves; the primary being the dorsal and the lower lumbar and sacral area; while the cervical and lower dorsal and upper lumbar form the secondary curves. Curves are normal and curvatures abnormal.

From an anterior posterior view the spine takes on two general pyramids. The large pyramid has its apex in the upper cervical region and the base at the fifth lumbar, and a second smaller pyramid with its base at the sacrum and the apex at the coccyx. Within the large pyramid there appears to be other pyramids; first, the entire cervical region with its apex at the axis and the base at the first dorsal; second, an inverted pyramid with its base at the first dorsal and its apex at the fifth dorsal, and the third pyramid with its apex at the fifth dorsal and the base at the fifth lumbar. This description gives one an idea of the variation in the size of the neural rings, for the spinal cord is largest in the cervical and lumbar regions and smallest in the middle dorsal region.

The spine consists of typical and peculiar vertebrae. The typical are from the third to sixth cervical inclusive, second to eighth dorsal inclusive, and the first four lumbars. The peculiar are the atlas, axis, seventh cervical, first, ninth, tenth, eleventh, twelfth dorsals, and the fifth lumbar.

In the cervical region the transverse, spinous processes, lamina and posterior arch are contacted. Points of contact in the dorsal area are the spinous processes, laminae, as well as the transverse processes. In the lumbar region the spinous and mammillary processes, as well as the laminae are contacted. Sacrum contacts are made on the upper tubercles for a posterior base, on the right or left superior portion of the base for rotations, and on the apex for a low anterior sacrum. The coccyx may be contacted externally for posteriority and internally for anteriority.

Though the atlas and axis have always been contacted more or less, the writer suggests that you hesitate in giving an atlas adjustment until you have thoroughly familiarized yourself with its descriptive parts and all directions as well. To consider the axis in the same manner may be exceedingly advantageous.

Spinographs have proved that the atlas rotates in its subluxation. To attempt to adjust an axis only because it palpates right or left of the median line may increase or de-

crease the normal alignment between atlas and axis. The pivots of axis must be first determined, then the laterality of the body to know where to make contact.

One cannot spend too much time in study of the descriptive parts, the normal and the abnormal or the anomalies and malformations of the spinal column. As you continue on through this text, no doubt you will readily realize why this hesitancy has been suggested.

The subject of spinal abnormalities is truly important. Such anomalies are, perhaps, the reason why many erroneous Chiropractic listings are made and no doubt it plays an important part in the case of border-line failures in specific adjusting.

Curvatures, exostosis and ankylosis, trauma, as well as the dissymmetry existing throughout the vertebrae are all included in the study of anomalies and malformations which we find daily in spinal X-ray examinations.

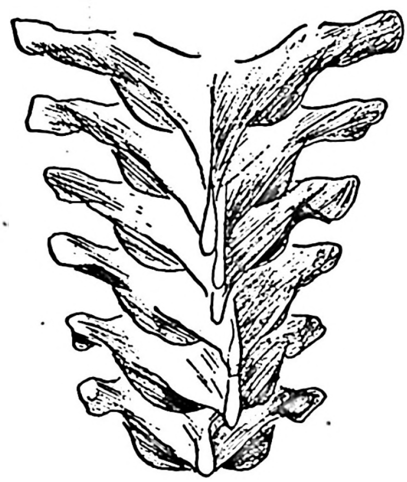


Figure No. 113
Left Rotation

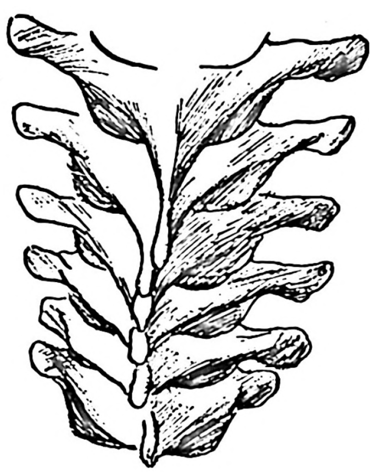


Figure No. 114
Right Rotation

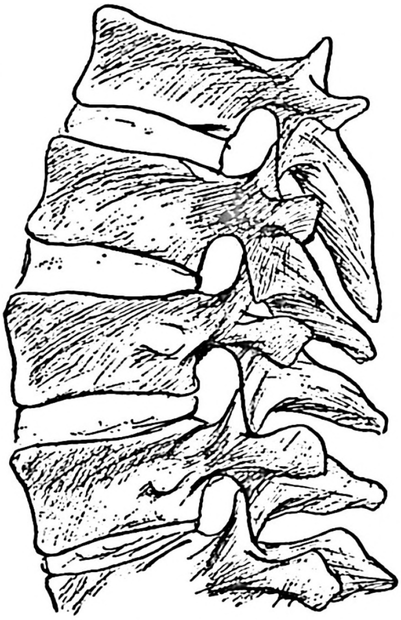


Figure No. 115
Lordosis

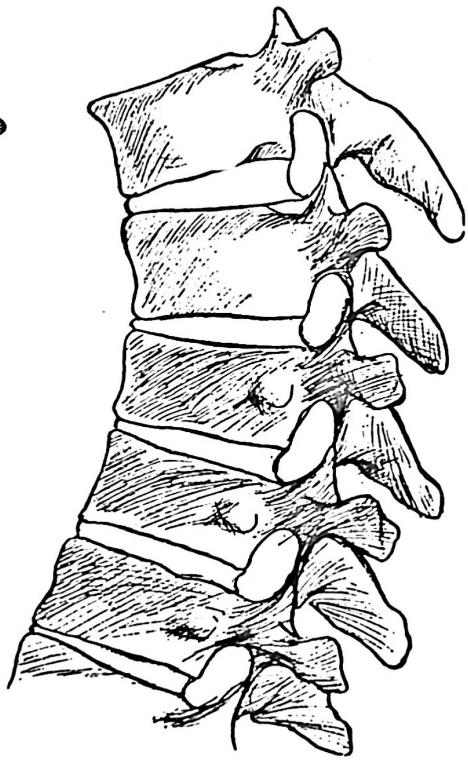


Figure No. 116
Kyphosis

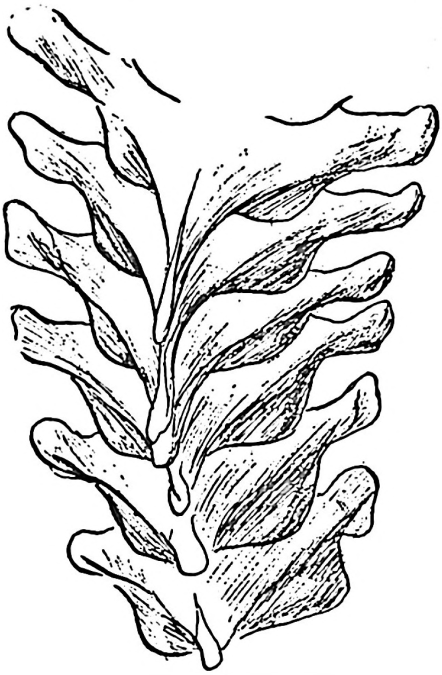


Figure No. 117
Left Scoliosis

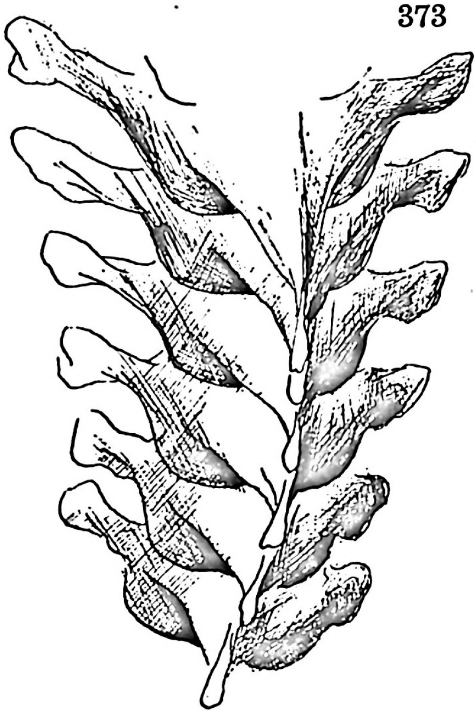


Figure No. 118
Right Scoliosis

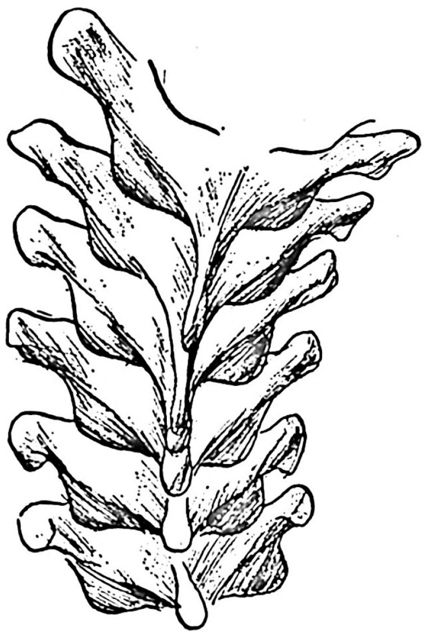


Figure No. 119
Left Rotatory Scoliosis

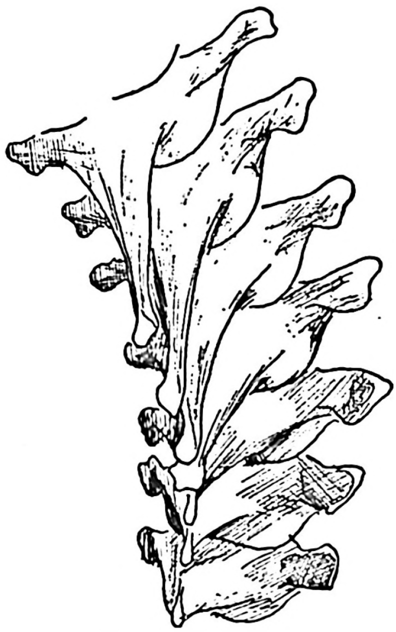


Figure No. 120
Right Rotatory Scoliosis

CHAPTER 32

SPINOGRAPHY

Spinography, entered the field of Radiography at the Palmer School of Chiropractic in 1910 and has continued to attract the attention of the scientific world. But only within the last few years has it reached the high degree of perfection which it now possesses. Until its birth, spinal subluxations, or misalignments as they are now regarded, were determined only by means of palpation. As a matter of fact, this method has been carried on more or less even to the present time. However, Dr. B. J. Palmer himself, and renowned individuals in the field of orthopedic surgery have admitted they were many times in error as high as 50 per cent or more. Experimentations and investigations which are constantly carried on, have revealed and have proved by the spinographic films why palpation could only be in error. So it is obvious that Spinography properly applied does more than read subluxations and misalignments. It reveals the degree of subluxations and misalignments, pathology, the actual existence and the location of exostosis or ankylosis, anomalies and malformations, and the abnormal contours, which in all could mislead any one in their palpation. All this should have revealed to the Chiropractor why his case did not get well, giving him the necessary information as to what he should have done Chiropractically, where and how he should have worked to have restored early health to the case he so unfortunately failed on.

Scientific research with scientific equipment has proved that the two higher points of manifestation afford quicker and more permanent Chiropractic results. This chapter is intended for the benefit of those who desire to adjust throughout the spinal column and to give step-by-step the progress of Chiropractic Spinography.

Chiropractically, the human body, referring to the spine is divided into zones, the boundaries being governed by the

distribution of the spinal nerves. So it is necessary that the spinographic technician working generally, expose and analyze the films according to zones for certain physical conditions.

It was first customary to X-ray the spinal column in five separate sections, using the 8 x 10 films with sufficient overlapping of spinal segments on either end of the film for com-

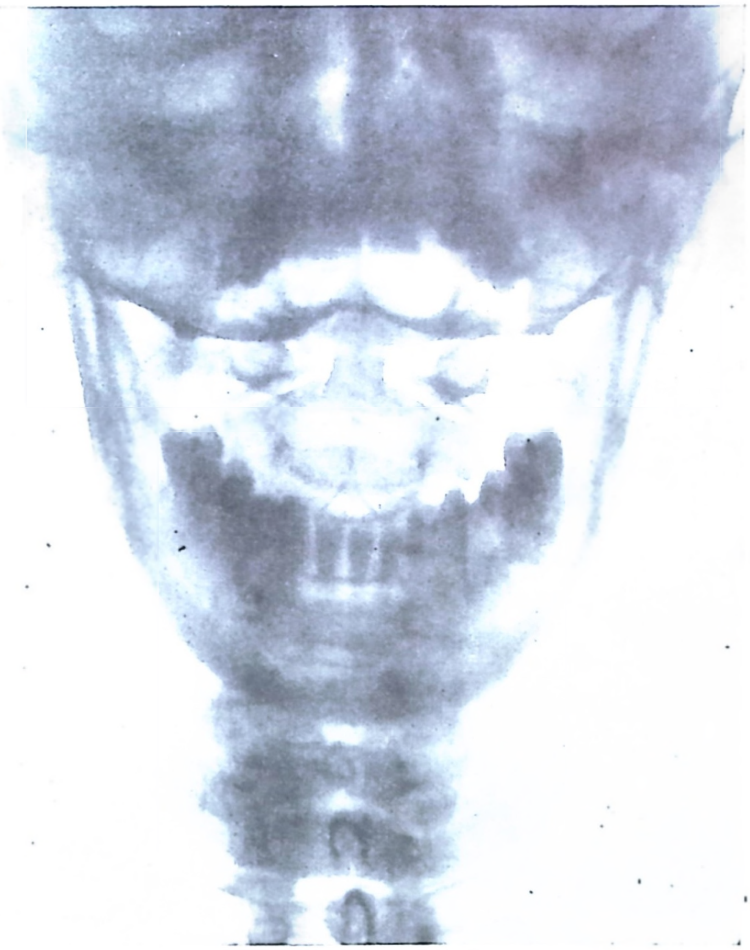


Figure No. 121
Atlas, Axis and Cervical

parison. In some instances 5 x 7 films were used instead of 8 x 10 for Atlas and Axis only, but the smaller size was later discarded and the 8 x 10 film is now generally used.

First section—exposure showing the atlas in the center of the film, centering the tube directly over or in front of the open mouth.

Second section—lower cervical and upper dorsal region including the sixth dorsal.

Figure No. 122
Lower Cervical and Upper Dorsal LC and UD

Third section—the lower dorsal film including the fifth dorsal and the first lumbar.

Fourth section—the entire lumbar vertebrae revealing the twelfth dorsal and the first tubercle of the sacrum as well.

Fifth section—the sacrum and coccyx showing the fourth lumbar down including the crest of the pubes.

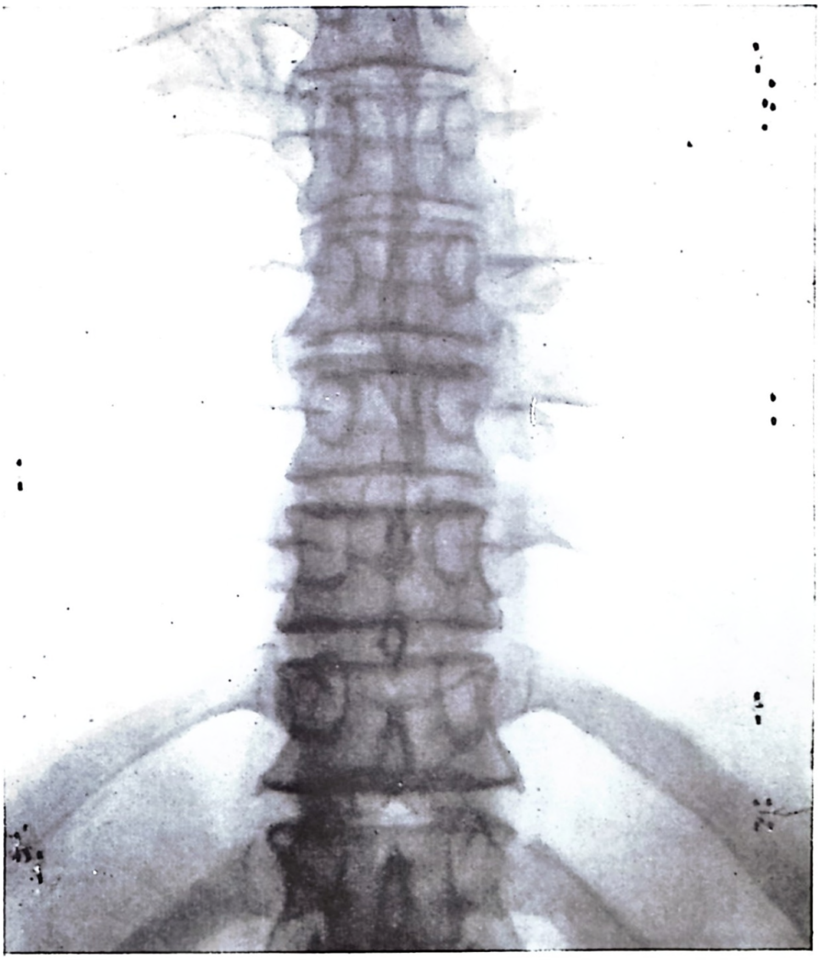


Figure No. 123
Lower Dorsal — LD

The tube in all instances (except for the atlas film) was generally centered directly over the mid-section of each region.

Then came the use of the 14 x 17 film covering one half of the film and cassette with 1/16″ sheet lead and exposing the other half; then vice versa, totaling two 7 x 17 exposures of the entire column. In the majority of cases this method was generally discarded because of distortion, the amount

Figure No. 124
Lumbar

of time involved in making the exposures, as well as the inconvenience in using this particular method.

Then the 8 x 36 film and later the 14 x 36 film became obtainable for taking the entire spinal column in one exposure. On the latter film the entire osseous structures were revealed. In either event the moving jaw technic was employed to give more visualization of atlas and axis, including the middle cervical areas. So far as subluxations and

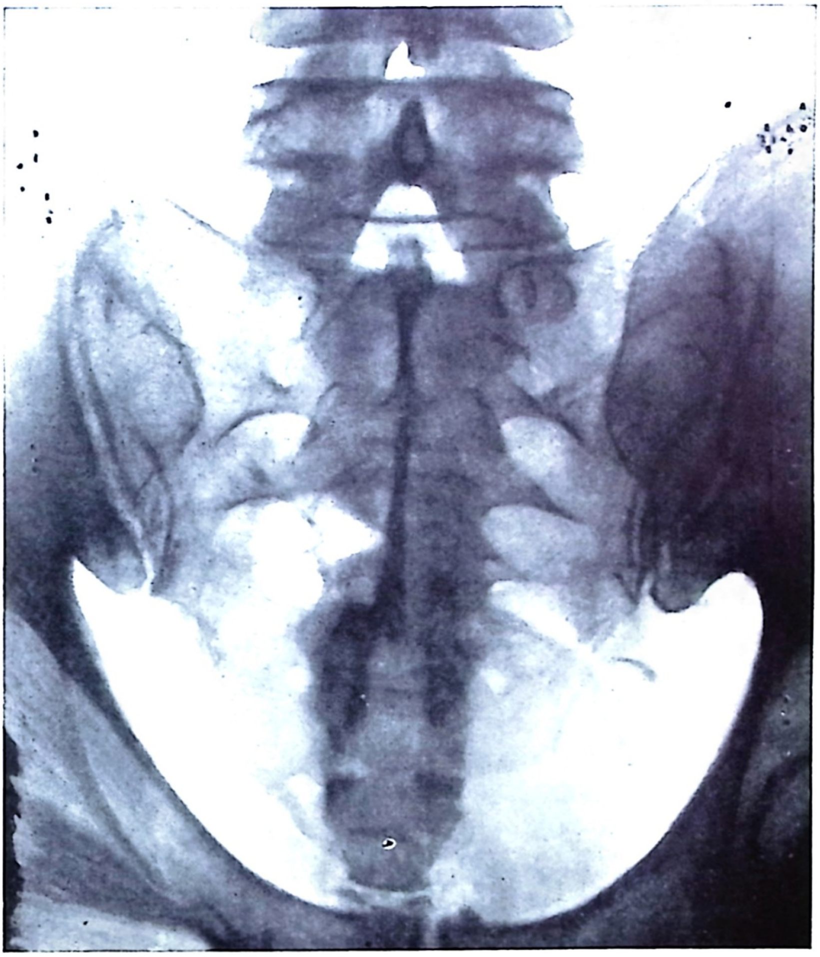


Figure No. 125
Sacrum and Coccyx

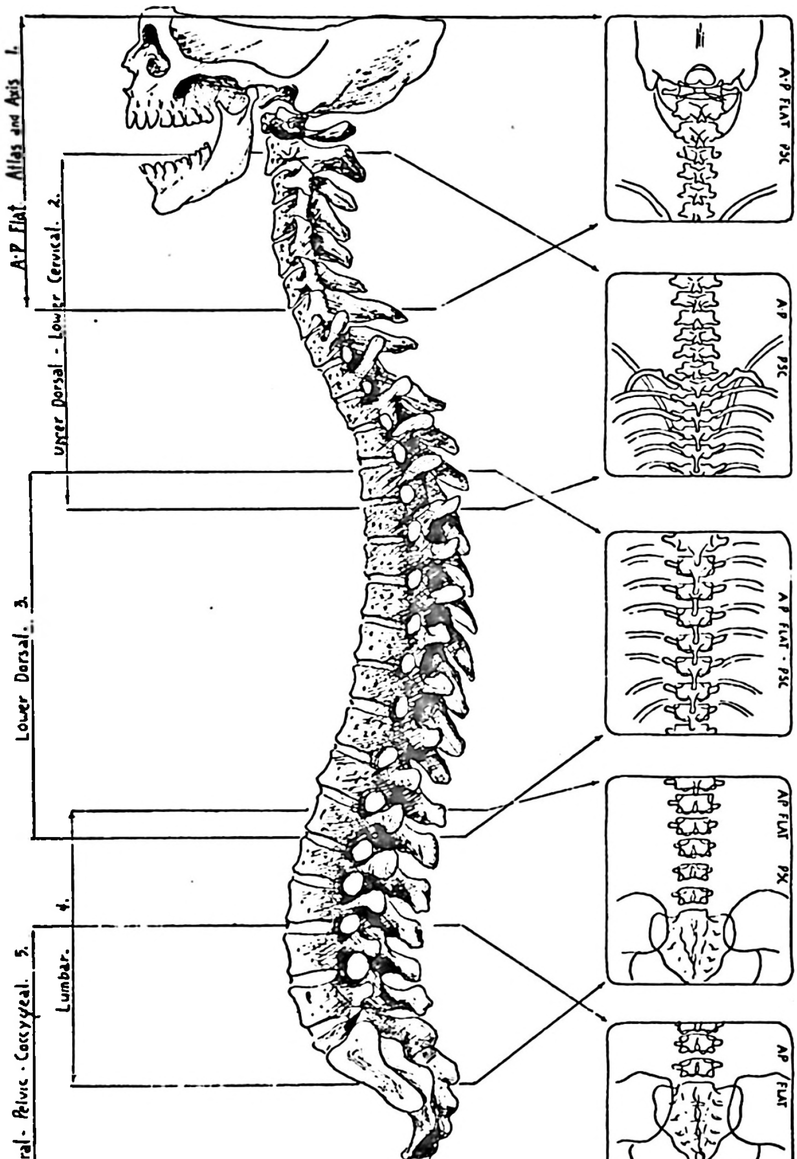


Figure No. 126
Entire spine, showing five sectional Meric views

misalignments are concerned, it was definitely decided that far better results were obtained generally when X-raying the spinal column in sections. Proper alignment of patient and tube greatly reduces distortion because of the lesser length of area exposed. In other words, to expose the entire spinal column on an 8 x 36 or even the 14 x 36 film, centering the tube approximately over the eleventh or twelfth dorsal vertebra at proper tube distance will give the approximate size of segments, correct contours, etc., of this particular centered area. But the extremities of the film will be greatly distorted, even so far as to blend or overlap certain segments on the film. This is particularly true of the upper cervical and lumbar regions. The greater the angle of rays, the more distortion is produced. If only the spinal contour is wanted the 36″ film is perhaps the better one to use.

Many times I have been asked whether or not ankylosis existed between the occiput, atlas and axis or the other extremity of the film because of the overlapping of these segments. Such appearances are the direct result of distortion. To get the actual size and shape one must arrange the tube to direct its path of rays directly over and above the segments in question as well as at right angles to the film. General distortion in the way of magnification up to a point where lines become fuzzy or more or less indistinct is not a menace in making a Chiropractic analysis but may be an asset to the one making the interpretation. Distortion resulting in elongation changing the contour of segments may result in an erroneous film analysis.

The moving jaw technic refers to the opening and closing of the patient's mouth intermittently with the exposure time. The purpose was to get a more definite outline of the cervical segments as seen on the X-ray film through the jaw with the mouth wide open. It is true that in some instances a better outline was made visible. On the other hand opening and closing the mouth caused contraction of certain cervical muscles causing the head to move during the exposure. Perhaps this slight degree of motion made only a

slight difference in reading flat films but in stereoscopic procedures it greatly interfered with the fusing of the films; therefore, the moving jaw technic has been discarded. Motion appearing on any X-ray film makes the film of little value.

Therefore better results are obtained by keeping the patient's mouth wide open during the exposure. A cork is placed between the patient's teeth for this purpose. Cork is the better to use as it is more or less compressible and will not offer enough resistance to the X-rays to cause any difficulty when interpreting the film.

Spinography is the term used to designate this particular phase of Chiropractic activity. The special X-ray technic involved with precision methods etc., is largely responsible for the present success of any method used in the Chiropractic field today.

Sufficient, extensive equipment, distinctively complete and up-to-date, should be maintained in any commercial X-ray laboratory. This is true of the equipment used at the Palmer School of Chiropractic. Such equipped laboratories make it possible to do the latest spinographic work. Incidentally, in school where this subject is taught the student should be given a thorough training in the precision manner of placing the patient and tube. For this has proved to be of vital importance in maintaining the maximum results in reading the spinographic films. They should be taught how to carry these films through the developing process in the darkroom after exposures are made. Every possible effort should be made to thoroughly instruct the student in this important phase of the work as well as the actual film reading itself. Perhaps the first step is the terminology used in Chiropractic X-ray work, then the operation of the machine which includes a general knowledge of all X-ray equipment, careful training in the handling of such equipment and accessories together with placement, etc., then continuing through all phases of Chiropractic stereoscopic X-ray procedure.

Proper placement of the patient prior to the actual exposure must be thoroughly embedded in the student's thought. Much stress should be placed on this particular phase of the work as spinographs improperly made will reveal erroneous positions and naturally the listings would be of no value. Developing the exposed film is likewise important for films may be ruined or made readable through the darkroom procedure.

Film reading (or analyzing) the finished spinograph requires a great deal of intensive study. One receiving a firm foundation in this work will have something to actually build upon when he enters his field of endeavor. Experience makes one more competent.

I respectfully persuade you to own and operate an X-ray machine and to do this work in a precision-like manner, regardless of what method in Chiropractic you have adopted. If for some very good reason you are not operating such equipment, send your case to someone doing this sort of work on whom you can rely as being competent and capable.

With continual practice one can train his eyes to discriminate between the outlines or lines of demarkation by comparing one with the other.

There have always been various opinions as to what constitutes the proper type of film for Chiropractic purposes; referring now to the light or dark film. Perhaps the most suitable type of spinograph is the one revealing pen-point, all white, clean, clear-cut outlines with a dark gray background rather than a heavy, not so white outline with a black background. The latter type is produced by over-penetration or over-exposure and in such cases the black background will always feather the white outlines making them fuzzy, not sharp and more or less indistinct. Then too there is always secondary fog to some degree in this type of negative. This is the result of too much KVP. In other words, it is my opinion the Chiropractor discerns more from his films when they are not so contrasty but clearly outlined; for he actually compares outlines with one another whereas the

medical profession prefers contrast for they compare areas within areas and are not so particular concerning outlines.

In spinal reading consideration is not only made of the spinous processes on the film, as is the case in palpation, but of other descriptive parts of the vertebra, the laminae and its junction, pedicles and mammillary processes, the articular processes and their surfaces, the bodies, the intervertebral disc space, the attachment of ribs and the transverse processes and any anomalies and malformations visible.

There are certain fundamental rules which must be applied and adhered to. These rules which are prepared for spinographic reading are the foundation upon which anyone who is thoroughly familiar with Chiropractic Orthopedy and Abnormalities, and X-ray technicalities, can become proficient in making an analysis. This proficiency is a matter of practice, mechanical perception and good judgment.

When beginning this particular phase of spinography the beginner must not measure his progress by the number of films he reads during any one period, but rather rate himself by the accuracy with which he proceeds. REMEMBER YOU WILL BE DEALING WITH SICK PEOPLE AND THE ADJUSTIC MOVE GIVEN WILL BE DETERMINED BY THE CONCLUSIONS REACHED IN YOUR FILM ANALYSIS. So naturally, film reading is very important and results can only be obtained by precision in all procedures, careful study and visualization. To know the case history together with symptoms makes it possible to know which zone should be spinographed. To carry the thought of contacts, standing positions and lines of drive when making the analysis acts as a check in verifying your reading. Each day the films taken present new and interesting conditions which require a great deal of thought and careful study. It is for this reason that I wish to again remark: THOROUGHLY FAMILIARIZE YOURSELF WITH THE NORMAL, SO THE ABNORMAL WILL BE LESS DIFFICULT TO INTERPRET. The cuts on pages 371, 372, 373 indicate rotations, and the abnormal spinal bendings. Inci-

dentally, three or more consecutive segments constitute a rotation or lateral bending. The abnormal spinal bendings are known as: lordosis, kyphosis, scoliosis, rotatory scoliosis, and kyphotic or lordotic scoliosis all with or without rotation.

Rule 1. The first rule for any spinographic reading concerns the correct placement of the film in the reading box.

A radiograph of the spine is really a shadowgraph picture. It is understood that any part or region to be X-rayed, radiographed, or spinographed must be in contact with or in close proximity to the film or cassette. For instance: if a spinal picture is taken to determine its subluxation or misalignment, the posterior portion of the spine is placed on the film with the path of X-rays directed from anterior to posterior at right angles to the film. Further, if one wishes to see the patella or knee-cap on the film, that particular part is placed directly over or in direct contact with the film or the cassette, directing the X-rays from posterior to anterior.

To expose and to read the spinograph in the same direction you would ordinarily palpate the spine, the spinous processes must point toward the film. In other words, that which you would palpate right you would also read right. So all spinographs should have a marker X-rayed on the film, indicating the patient's right side and such a film is placed in your viewing box with the marker at your right side looking through the film from posterior to anterior.

Years ago glass plates were emulsioned on one side only and it was very necessary that you determine in the darkroom, under the safe-light, the emulsion side of the plate and during the exposure the emulsion side contacted the object to be X-rayed; but today X-ray films are duplitized, meaning the same amount of emulsion is coated on both sides of the film's base. Naturally, either side of the film is efficient. It is only a question of properly marking the film and having that marker at the proper side as you read the film. It has long been customary among roentgenologists and X-ray technicians that a marker be placed on the film

at the patient's right side. This rule should never be broken, particularly in spinographic work.

Rule 2. This rule determines the various landmarks in order that one may be sure in correctly counting the vertebrae on the film. Reading the lower cervical and upper dorsal film, count should begin at the first dorsal counting up and down. It is understood that the spinous processes in the cervical region are usually bifurcated while those in the dorsal and lumbar regions are not.

The first dorsal has the attachment for the first pair of ribs, a whole and a demi facet. The first pair of ribs are rather small being circular in shape, usually extending downward over the second and third pair of ribs on the film. The first dorsal transverse processes point upward. The transverse processes of the 7th cervical are large and point downward. In other words, the transverse processes of the 1st dorsal and the 7th cervical point together forming a sort of V or wedge with the point extending laterally. Though the 7th cervical is known as the vertebra prominens many times, the spinous of the 1st dorsal is the largest and may palpate as the most prominent in this region.

Knowing the pecularities of the vertebral segments one should be able to easily determine the first dorsal vertebra.

Lower Dorsal film—Beginning at the 12th dorsal, count up. The 12th dorsal vertebra carries the dorsal characteristics in its superior portion and the lumbar features in its lower portion. It usually has attached to it, the last pair of fully developed ribs, although in some cases they are only rudimentary. This may be true in some instances of the first lumbar vertebra. So with careful study there should be no reason for confusion in determining the 12th dorsal vertebra.

To further verify the 12th dorsal, count up three spinous processes on the film including the 12th dorsal spinous. This should locate the 10th dorsal spinous process. It usually appears very small on the film and in all probability would palpate as an anterior spinous process. This is many times

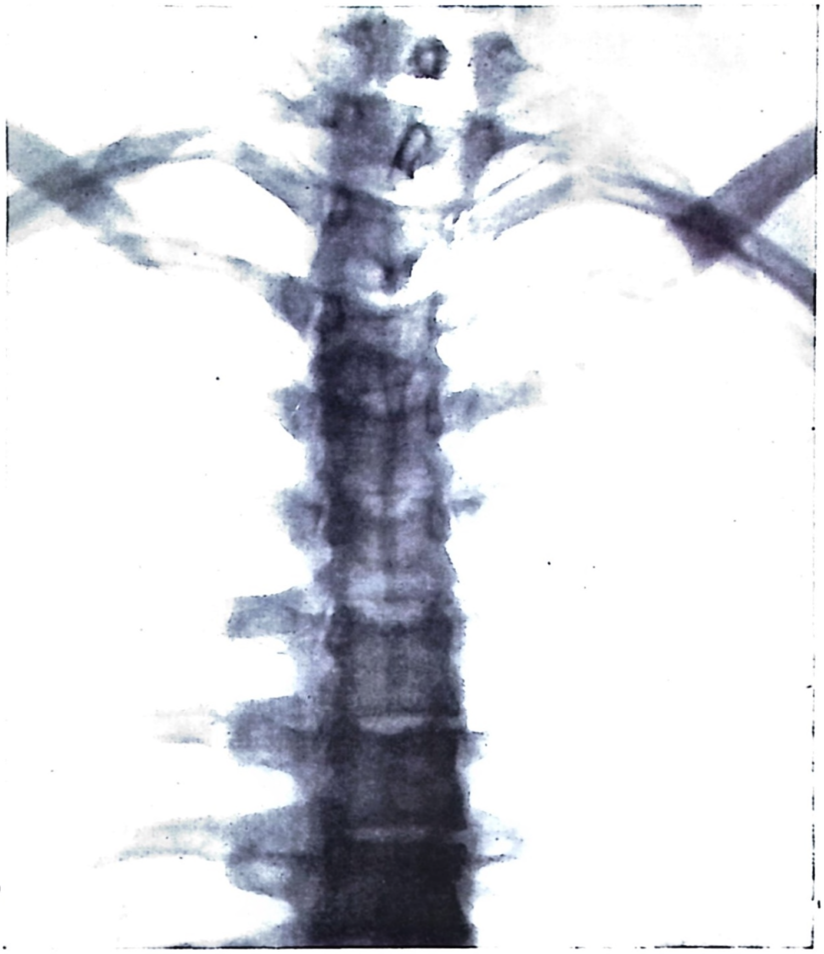


Figure No. 127
First Dorsal down

overlooked by the Chiropractor in his palpation. The 9th dorsal has a whole and a demi facet and this spinous is usually long, extending down over the spinous process of the 10th dorsal vertebra. The 10th dorsal spinous process does not usually extend down over the 11th but if it does, the overlapping is not very great.

There is not a great deal of difficulty present when attempting to determine the count on the lumbar film even

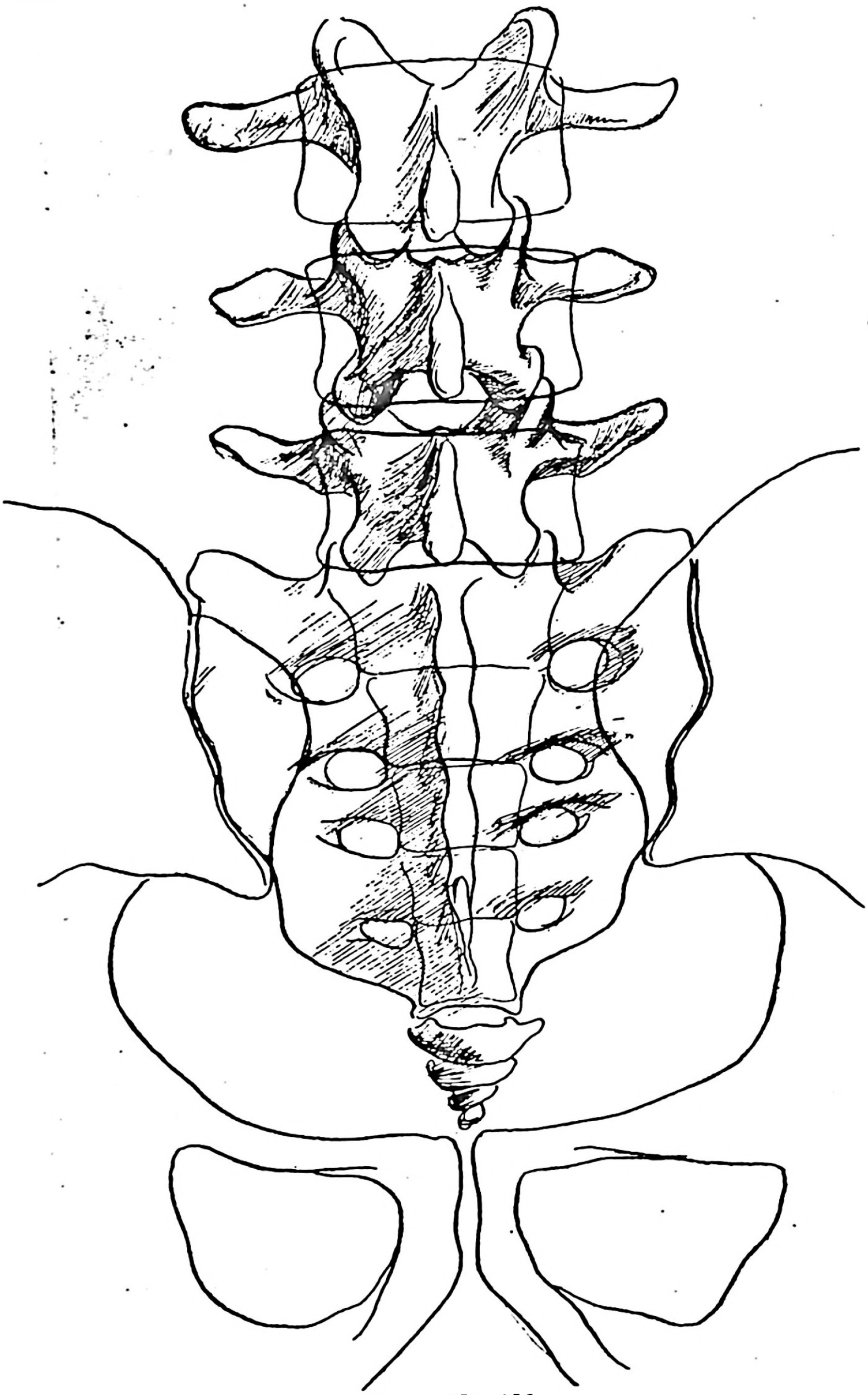


Figure No. 128
Lower Lumbar Sacrum and Coccyx

though the 12th dorsal does not appear on the film as long as the first or second tubercle of the sacrum is present. Certain features of the 5th lumbar spinous and lamina as well as the body itself are usually quite prominent and should be considered when the 5th lumbar is the last segment shown on the film. First, its spinous process is usually very short, thick, and large. In fact, it is the largest spinous process in the lumbar region. The body of the vertebra is not as thick as are the bodies of the other lumbars, and the laminae are narrow tipping to the superior, causing the 4th and 5th lumbar spinous processes to appear nearly together. In other words, there is a lordotic condition at this point causing the anterior edge of the 5th lumbar to tip inferior and the posterior portion superior. One should be cautious when listing exostosis and ankylosis of this particular area as the mammillary processes are quite large though they may have a lesser density than the vertebral bodies themselves. This may appear in a form of exostosis or ankylosis when in reality neither condition is present.

Rarely we find a movable extra lumbar. Occasionally we find a false segment, so to speak, fused to the sacrum. However, if one knows the articulations of the 5th lumbar and sacrum this appearance will be readily recognized.

Rule 3. Pertains to the anomalies and malformations visible throughout the spine or spinal column, such as cleft or bent spinous processes, exostosis or ankylosis, exostotic growths on the tip of the spinous process, long and short spinous processes, wedge-shaped bodies, etc. This rule also covers dislocations, either partial or complete and fractures as well.

Rule 4. This rule will differentiate between the various types of lateral bendings and their directions or whether just a rotation of the vertebral segments exists.

Though mention has been made of the various spinal bendings and their directions, perhaps it would be well to repeat them: LORDOSIS is the abnormal anterior bending while KYPHOSIS is the posterior curvature. These

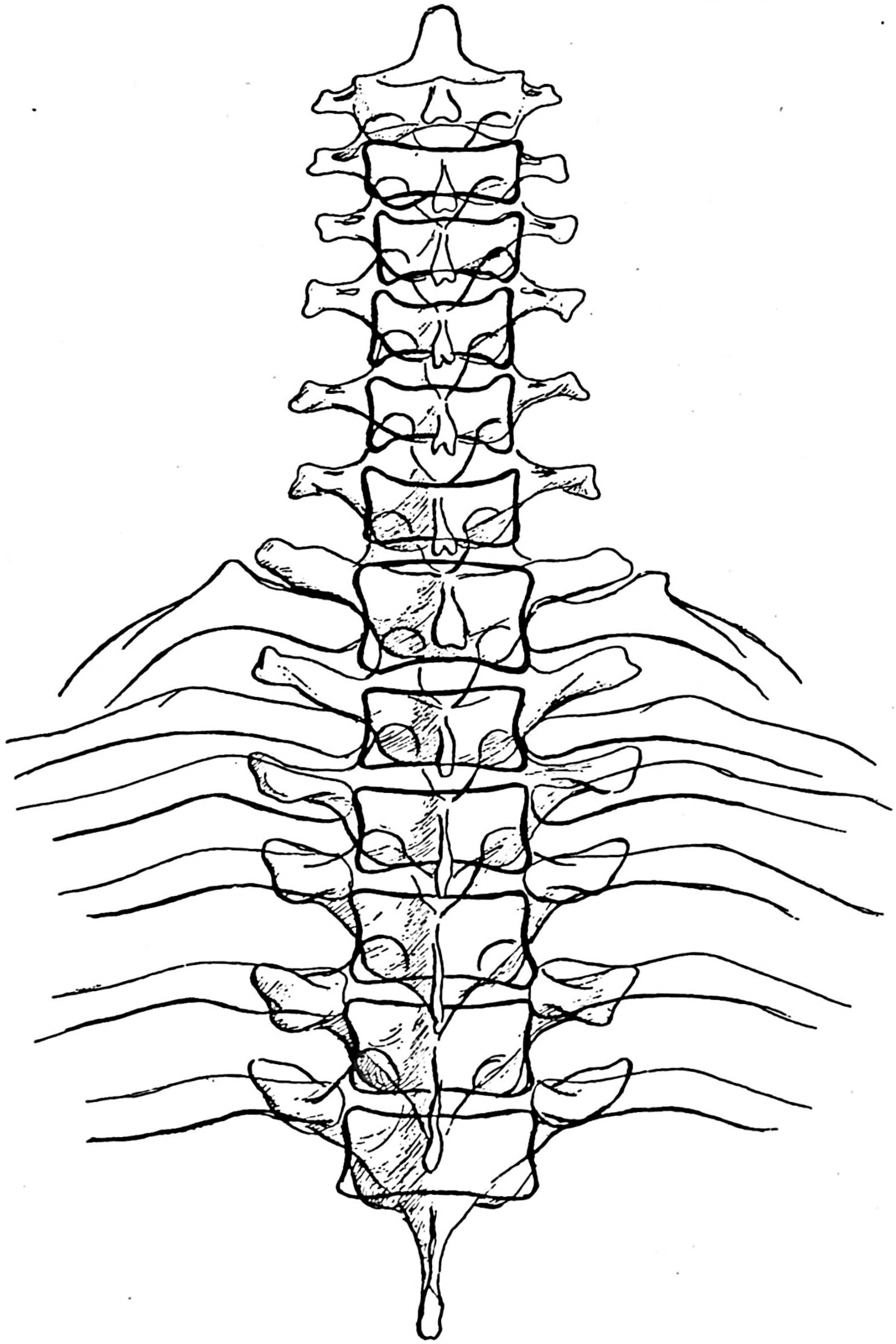


Figure No. 129
Lower Cervical and Upper Dorsal

two are only determined by lateral views. SCOLIOSIS can be either right or left with the spinous processes either in the median line of the curve or slightly towards the convexity. A ROTATION is the rotating of three or more adjacent segments in the same direction without any lateral bending. A ROTATORY SCOLIOSIS which may be either right or left is the lateral bending of the segments with the spinous processes conforming to the concavity of the curve. In other words, a ROTATORY SCOLIOSIS is a scoliosis plus a rotation, the two coinciding in the same direction. A KYPHOTIC ROTATORY SCOLIOSIS is a combination of a scoliosis, a rotation, and a posterior abnormal bending or kyphosis.

Only when three or more adjacent segments appear to be directly affected, are the above mentioned spinal curvatures or rotations listed.

It has always been customary to make mention of the apex of the curvature. However, it is not advisable to attempt to list the apex as a misalignment unless the apex is actually misaligned with the segment above and the segment below. Though the apex is the extreme outer point of the bend, it is most likely to be aligned with the one above and the one below within the lateral bending. A misaligned vertebra being the apex of the curvature is a rather rare occurrence.

Rule 5. The next step is to locate the junction of the laminae. This point anatomically should be the center of the neural ring at the posterior and should not be mistaken for the bifurcation or tip of the spinous process as the case may be.

Oftentimes the center of the tip of the spinous process is used as a point to begin measurement from or sometimes the superior part of a bifurcated spinous process. This is absolutely incorrect. These particular centers may be found right or left of the junction of the laminae. So to use this point of measurement may cause confusion and perhaps an erroneous listing.

Usually on all spinographic films, and this is particularly true of stereoscopic pictures, a fine light line will be seen extending from the tip of the spinous process to the junction of the laminae or at least towards that point. To follow this light line as far as possible towards the junction of the laminae will determine the point from which measurements are to be made.

Rule 6. This rule is given to determine the median line. There seem to be various opinions as to the median line or that imaginary plane line used in our daily routine of plate reading. I now refer you to the subject of Orthopedy which teaches the normal spine and its anatomical articulations of one vertebral segment with another. It is through the study of this work that you will obtain a mental picture of the median line.

Rule 7. Refers to the relationship of the spinous process with its own body on the film and with the median line as well. If the spinous process or that point from which measurement begins is right of its own body this does not necessarily indicate a right misalignment of the one in question with the one segment above and the one segment below. A misalignment refers to the position of the junction of laminae with the body of a vertebra and the median line compared with the one above and the one below. The junction of the laminae must be right of its own body and right of the median line as well, to produce a right misalignment.

Rule 8. Refers to the relationship between the median line and the junction of the laminae. For instance, if the junction of the laminae is found right of the median line indications are that the body has rotated left, the spine bends to the right or the laterality is right. However, this is not true in every case. If the junction of the laminae is right of its own body, the body has rotated left, but laterality or curvature may force the junction of laminae to the opposite side of the median line.

Rule 9. This method determines laterality. Knowing the junctions of the laminae and the curvatures, if any, the

first step is to measure from the junction of the laminae of the vertebra in question to the white crescent marks on either side of the spinous process near the outer edges of the body. The white crescent-shaped marks indicate the pedicles of the vertebra.

The junction of the laminae anatomically should be the center of that particular neural ring. When it is found nearer the right side than the left side, the body has rotated left. If that point is nearer the left side than the right, the body has rotated right.

In order that this may actually be a misalignment the junction of the laminae must be either right or left of its own body and correspondingly right or left of the median line. Remember, right or left of the median line, disregarding its position, does not indicate a right or left misalignment. It may indicate that the one above or the one below is the misalignment, Also it may indicate a rotatory condition. This particular segment may be the apex of the curvature and not rotate to the same degree as the one above or the one below, or both. In that event the one above or the one below would be the misaligned vertebra.

When two segments appear to be rotated in the same direction and not to quite the same degree, with or without lateral tipping, the one having the greater degree of misalignment should be checked. Again, where two segments appear to be the ones in question yet assuming opposite directions in laterality with or without lateral tipping, both should be checked as the misalignments.

REMEMBER, WHEN LISTING A LATERAL MISALIGNMENT, THE JUNCTION OF THE LAMINAE MUST BE FOUND, EITHER TO THE RIGHT OR THE LEFT OF THE MEDIAN LINE AND IT MUST CORRESPOND WITH THAT SIDE OF ITS OWN BODY.

Rule 10. Refers to the general tipping of the segments below the atlas at the side of laterality. A vertebra may angle up or down laterally within its rotation or curvature. It may or may not be the vertebra in question; however, add

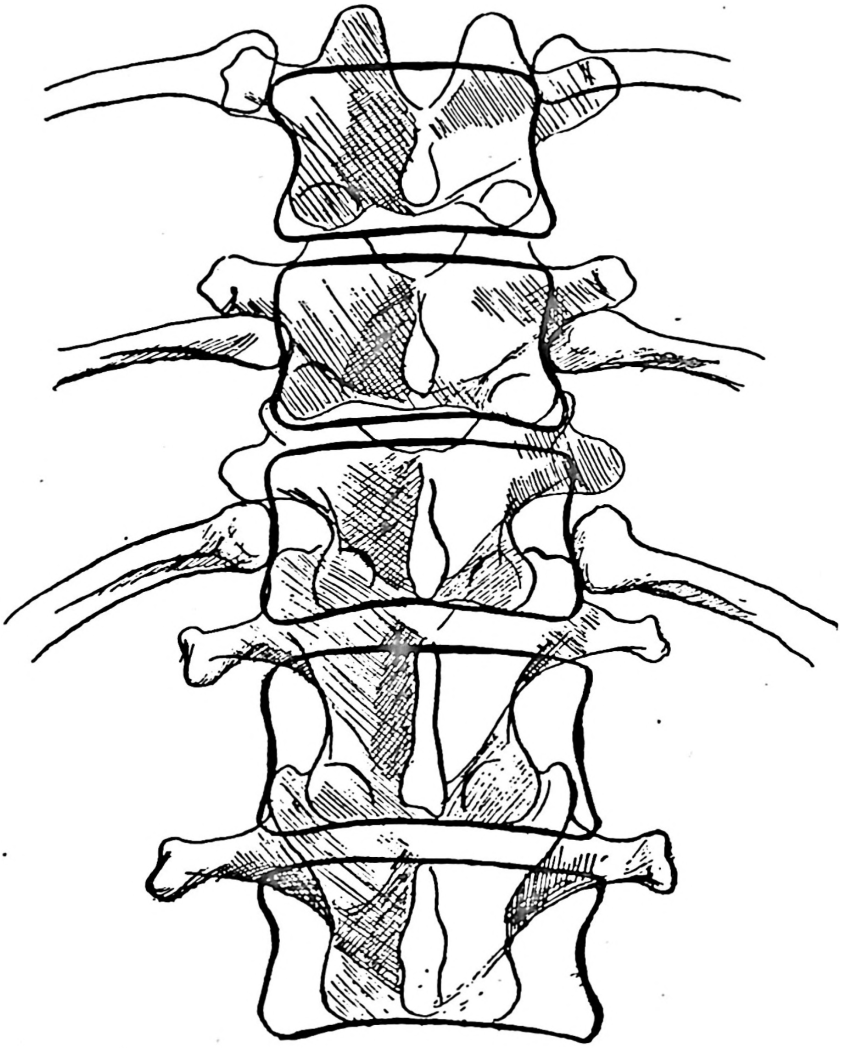


Figure No. 130
K.P. Center

the angling up superior or down inferior to the side of laterality of the one in question.

Rule 11. Refers to the general inferior or superior angling of a segment. In other words, a segment may be occasionally found with particularly no rotation or laterality of spinous process nor any particular lateral angling up or down but having moved to a lordotic or kyphotic condition. In this event the junction of the laminae will take on an abnormal inferior position or an abnormal superior position.

Rule 12. Determining the misaligned Sacrum — Under the old system of adjusting it was often said that this particular part of the spinal column was more or less neglected. Great care should be exercised in attempting to read the misaligned sacrum before reaching any definite conclusion as to its misalignment. In many cases, what appears to be a misalignment on the film is merely an adaptation to a condition above.

To list this type of film the 4th and 5th lumbars should be included in the exposure. This makes it possible to obtain a more accurate comparison of the lower lumbar spinous processes and the tubercles of the sacrum.

It is unwise to attempt to make such a listing without first taking the 5th lumbar into consideration. Note whether or not there is any rotation at this point, whether or not the sacrum is rotated with the pelvis or otherwise, and whether it is tipped laterally and anterior. Note the anomalies or malformations such as dissymmetry in contour, incompleteness of posterior arch, bent spinous process, junction of laminae forming spinous process, and the articulation of this segment and sacrum.

Next study the posterior ossification of the sacrum, noting which tubercle or tubercles seem to indicate the posterior center of this region. This is usually the 2nd or 3rd tubercle. The 1st tubercle is usually malformed or incomplete so it is unwise to attempt to use this particular one as a matter of comparison. To use the 1st tubercle would in all

probability cause a contradiction and perhaps promote an erroneous or untrue listing.

Rule 13. Having noted all anomalies and malformations, throughout this region, locate the junction of the laminae of the 5th lumbar and center of the 2nd or 3rd tubercle of sacrum; then compare one with the other. This should give you the first check on sacrum rotation. If the 5th lumbar is not rotated the tubercles of the sacrum in question will be found left of the median line when its base on the right side is posterior.

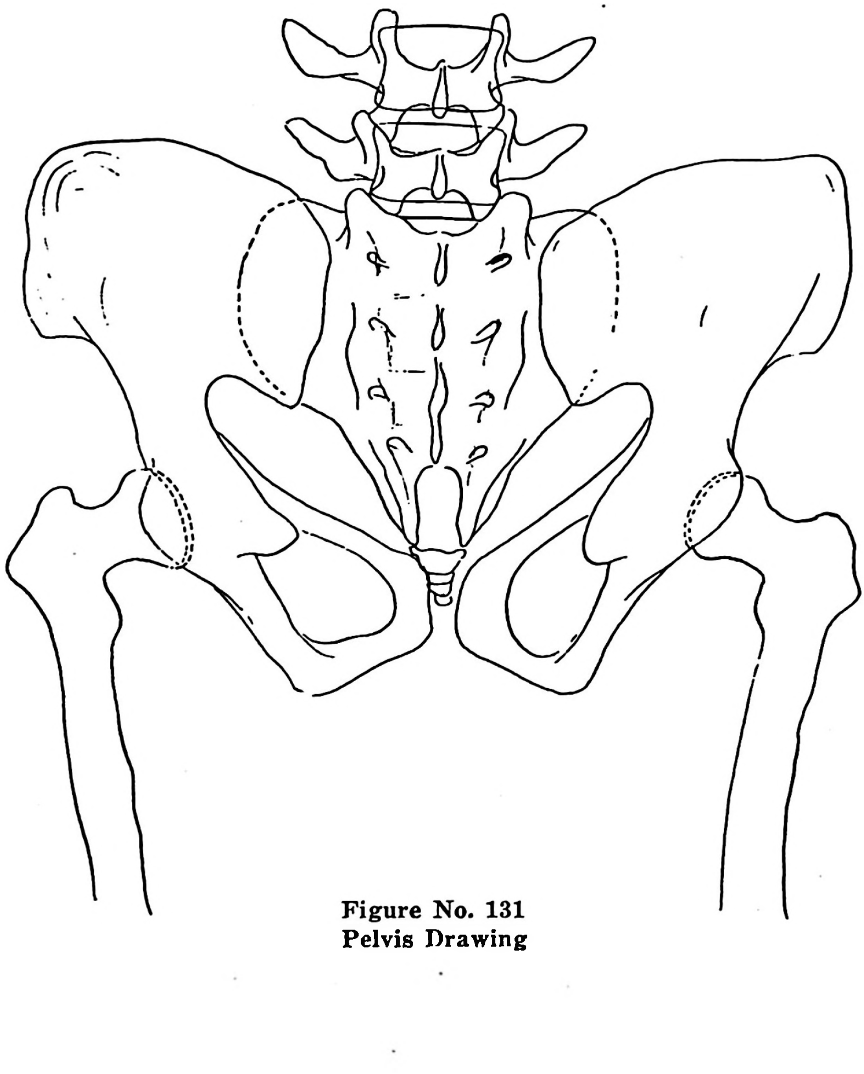


Figure No. 131
Pelvis Drawing

Rule 14. Further checking the rotation of the sacrum, again locate either the 2nd or 3rd tubercle indicating the posterior center of the sacrum; then measure up to a point on either side of the sacrum where the sacrum and superior portion of innominate bones meet on the film. Another way is to measure from the same point of the sacrum to an internal point of ilium or where the ilium and sacrum articulate at what is called the sacro-iliac articulation. In either event the sacrum rotating posterior will cause a greater distance to appear on the film between the sacrum tubercle and the sacro-iliac area. Also when the base of sacrum is posterior usually the shadow indicating the sacro-iliac articulation is wider, more prominent, more clearly defined than the opposite side. If the sacrum and the entire pelvis rotates, the width of the ilium just superior to the acetabulum will increase on the side of posteriority and decrease on the side of anteriority.

Rule 15. Though a posterior sacrum base should appear in detail on the film the anterior apex lacking in detail is really not sufficient information to reach such conclusions. The lateral film is necessary. Perhaps the most definite check in sacrum misalignment from this view is to first consider any lordotic condition which may be prevalent in the lower lumbar region. Next, make note of the shape of the space as seen on the film between the superior part of the sacrum and the inferior part of the body of the 5th lumbar articulation. If the sacrum base is actually posterior, the space between the sacrum and the 5th lumbar will form a wedge point to the anterior. If the apex is anterior the tendency of the point of the wedge would be to the anterior. If the base of the sacrum was actually posterior this space may or may not be rectangular in shape but the anterior edge of the sacrum and the 5th lumbar articulation would generally indicate the posterior base. When there is leg deficiency (with patient standing) due to misalignment and not the result of trauma or congenital malformation, the apex of the sacrum is found low and anterior on the side which

the long leg exists. In other words, the extreme superior point of both legs should be level. When one is lower than the other there is leg deficiency on that side.

Rule 16. This refers to the misaligned coccyx. The coccyx may be misaligned on the film in two directions; either right or left of the median line, and anterior or posterior. The median line here extends downward and parallel from the center of the sacral hiatus and usually should be in line anatomically with the symphysis pubes. A right coccyx will be found right of this median line. A left one will be found left of the median line.

Rule 17. This refers to the anterior or posterior coccyx. A lateral film of the sacrum is necessary in determining such positions of the coccyx although the AP view may give one an idea as to these directions if same is somewhat exaggerated. To see the superior border of the coccyx clearly with detail and contrast and its inferior portion not so clear is indicative of an anterior coccyx. Whereas in a posterior coccyx, its tip end should be clear and quite well defined providing such black shadows as gas and fecal matter do not obstruct the view. The anterior or posterior coccyx breaks the continuity of the arch made by the lateral contour of the sacrum.

Rule 18. When determining the misaligned superior ilium, caution must likewise be exercised to make certain that such appearances of the ilium are not indicative of a misalignment but rather one of an adaptative condition. If a scoliosis or a rotatory condition exists above this part, the chances are that the pelvis has tipped or will tip adaptatively. Also when one limb is actually shorter than the other the pelvis naturally tips to adapt to this condition. So again let me stress the fact that in many cases such misaligned appearances are not misalignments but are rather adaptative to a condition above this point.

The first step is to draw or imagine a line contacting the very superior crests of the ilia, and a second plane line contacting the very superior portion of the acetabulum as seen

on the film. Then note the superior line of both halves of the symphysis pubis. If one half of the symphysis pubis is superior to that of the other half, this would perhaps indicate a superior crest on that side. However, much study of anomalies and malformations must be made before using this point in forming a conclusion. Measuring the distance from the bottom of the film on either side of the pelvis to the inferior plane line or that through the acetabulum would indicate a superior iliac crest providing the distance was greater from the bottom of the film to the superior portion of the acetabulum on the side in question.

Further points would indicate a superior crest when both plane lines were diagonally higher on the side indicating superiority. These two plane lines may or may not be parallel even though the one ilium is actually misaligned towards the superior. The superior or top plane line, if not parallel with the line at the top of the acetabulum, would indicate a malformed superior crest. So to use the top line to determine a superior crest is absolutely unwise.

When using the large film with the patient in the standing upright position it is not advisable to attempt to balance the pelvis when making the exposure. This would by no means place the patient in a normal position. The normal relaxed position in placement is the only way to make such films with any accuracy. For this type of work, the tube should be centered at a point half way between the superior crest and the symphysis pubis in line with the vertical center of the sacral hiatus.

Please remember that when arriving at posterior, anterior, or inferior positions of any of the spinal segments, lateral films are necessary.

Date..
NAT..
STEREO..
EXTREM..
REGIONAL..

PAID
NO....................
YES....................

NAME ....
ADDRESS ....
CASE REFERRED BY ....
ADDRESS ....

LAT. VIEW NATURAL

1.
Atlas ....
....
Axis ....
....
Cerv. Curvature ....

A-P VIEW NATURAL

2.
Atlas ....
....
Axis ....
....
Cerv. Curvature ....

A-P STEREO.

3.-4.
Atlas ....
....
Axis ....
....
Rotation ....

DIAG. STEREO.

5.-6.
Atlas ....
....
Axis ....
....
Rotation ....

VERTEX STEREO.

7.-8.
Atlas ....
....
Axis ....
....
Rotation ....
Malformation ....
FINAL ....
....
....

Cervical
Atlas ....
Axis ....
3rd ....
4th ....
5th ....
6th ....
7th ....

Dorsal
1st ....
2nd ....
3rd ....
4th ....
5th ....
6th ....
7th ....
8th ....
9th ....
10th ....
11th ....
12th ....

Lumbar
1st ....
2nd ....
3rd ....
4th ....
5th ....
Sacrum ....
Coccyx ....

....Spinographer

Figure No. 132 — Film Envelope

CHAPTER 33

ATLAS AND AXIS SPECIFIC SPINOGRAPHY
(Flat or Natural Films)

During the year 1930, Dr. B. J. Palmer, to whom this book is dedicated, changed from his Meric system of teaching and practice to a newer way. He called this Hole-In-One.

This change was made almost over night, although for years he had been working on this idea. As a matter of fact, his father before him worked along these lines. Therefore, the principle of atlas-axis specific in Chiropractic is not new yet its application may be considered so.

The entry of this theory played a very important part in the actual spinographic procedure, so much so that it was definitely realized that palpation could no longer be relied upon. Spinography became a necessity. Not only was this true, but more detail and accuracy had to be employed. Immediate and extensive campaigns on better pictures began, and today the quality and precision of spinal pictures are obviously unexcelled.

The Lateral and AP flat films ordinarily reveal the first three directions in atlas subluxation, and give some indications of atlas rotation. The position of the occiput at the side of atlas laterality, the pivots and body laterality of the axis, together with its posterior inferior position are revealed; also lateral, anterior, and posterior bendings are determined.

Lateral Flat

The lateral flat film is made from a true lateral position (shoulders at right angles to the film) with the patient in the sitting upright posture. This posture is always the better for spinal pictures as the patient is in a more normal relaxed position. This undoubtedly is the position which made it possible to know the approximate degree of subluxation. The tube should direct its rays at right angles to the center of the film with the patient properly centered be-

tween. The central beam of X-rays should be directed slightly below the external auditory meatus.

The string method has proved to be quite practical when making this alignment. One end of the string is fastened to the tube indicating the center of the target while the loose end is placed directly in front of the patient's face slightly below the meatus.

Figure No. 133
Cervical Lateral Natural Film

Incidentally, the film may be placed at either side of the patient's cervical region for this particular type of film unless pathology, fractures, dislocations (either partial or complete) are suspected. In that event, the side in which such conditions may exist should be the side at which the film is placed. Otherwise the side is to be determined by a convenient manner of procedure in the laboratory.

1. The lateral film reveals the approximate amount of anteriority, which is that space appearing on the film between the anterior ring of the atlas and the odontoid of axis. It is the first direction in atlas subluxation and seems to be more or less prevalent in all atlas subluxations. This is the first step in lateral cervical reading.

Figure No. 134
Atlas and Axis — A to P view

2. The second direction is that of superiority or inferiority as the case may be. These directions refer to the anterior ring only. Though the anterior ring may point up or tilt down at the anterior, its transverse process on the side of laterality may assume the opposite angle. In other words, the anterior ring may point up (superior) and its transverse on the side of atlas laterality may point up or down due to either the side-slip, cervical bendings, or anomalies and malformations. This prevents any accuracy in palpating the transverse process of atlas for either superiority or inferiority.

To determine superiority or inferiority on the film, first locate the anterior center of the anterior ring and draw a

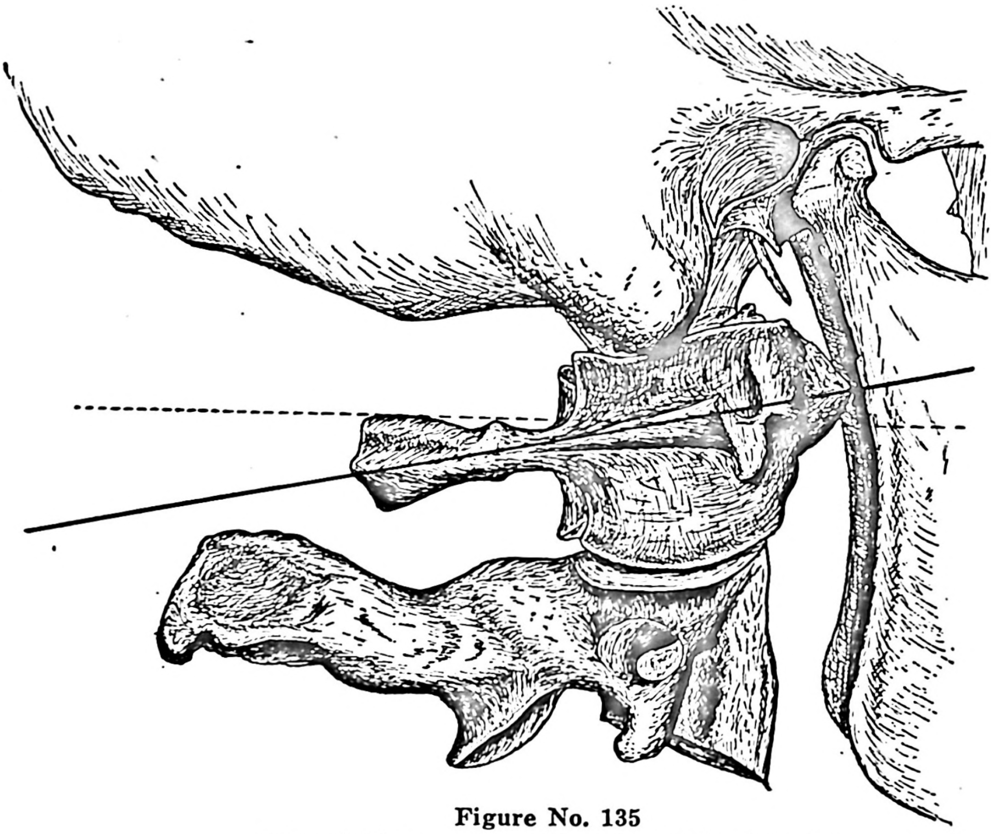


Figure No. 135
Lateral View — Atlas Superior at its Anterior

plane line from this point to the tubercle of posterior arch. When the line points up at the anterior and down at the posterior, the atlas is considered superior. When the line points down at the anterior and superior at the posterior, it is said to be inferior.

A good way to illustrate this is to think of the anterior ring of the atlas as the nose of an airplane and the posterior arch as the tail. When the airplane is headed downward, think of the atlas as being inferior. When the nose of the airplane is pointed upward, think of the atlas as being superior.

When the atlas is superior with axis normal from this aspect, there is usually a wedged-shape space between the

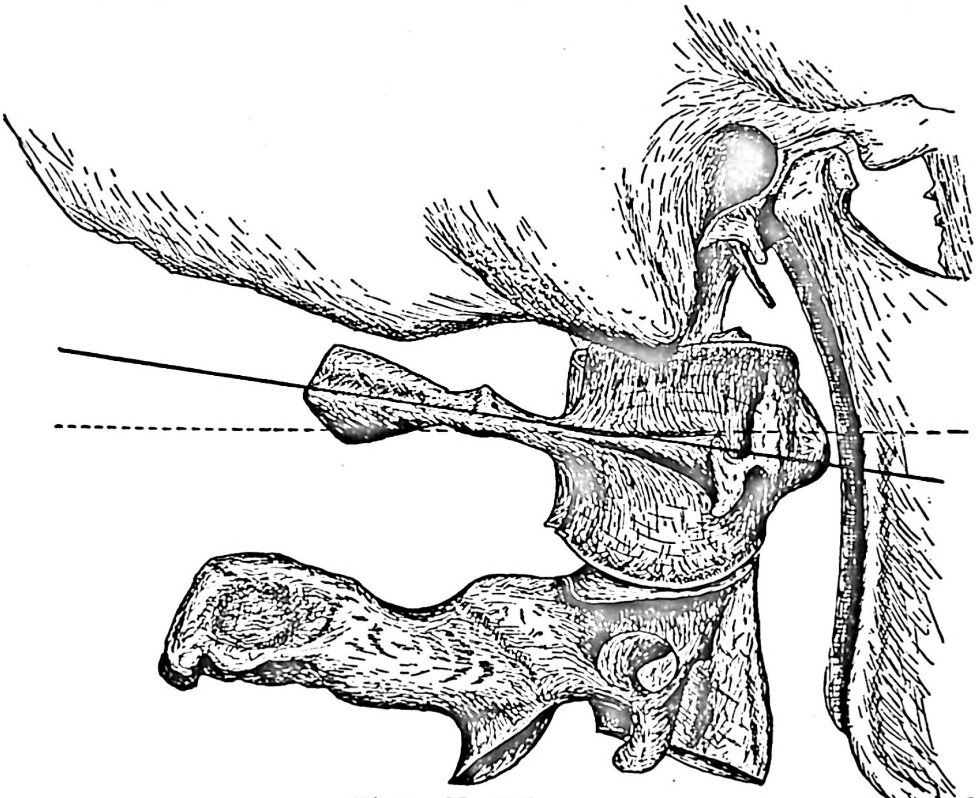


Figure No. 136
Lateral View — Atlas Inferior at its Anterior

anterior arch and odontoid with the point of the wedge upward; vice versa when the atlas is inferior. A posterior-inferior axis or anomalies and malformation could reverse this rule.

A normal atlas visualized from this angle would be nearly horizontally level though it would actually carry a slight degree tilt upward at the anterior. The spaces between the occiput and the posterior arch, posterior arch and spinous of axis should be nearly the same or perhaps slightly larger between occiput and posterior arch, providing anomalies or malformations did not exist at this point of axis and skull.

3. The Posterior-Inferior axis is not actually a common misalignment although it appears so on the film, usually due to a lordotic condition. It is always wise to first consider the anterior bending of the cervical region before reaching any conclusion as to a PI condition of the axis. When the axis is actually Posterior-Inferior, the dark line as seen on the film indicative of the space between the zygapophyses of axis and 3rd cervical makes a definite point of wedge towards the posterior—the blunt towards the anterior. The white line on the film indicating the posterior part of the body of axis changes its continuity in relation to such lines forming the arc at the posterior of the entire cervical bodies. The intervertebral disc space between axis and the 3rd cervical also makes a wedge with its point to the posterior and the blunt to the anterior. It will be further noted that each half of the intervertebral foramen does not make a foramen true in anatomical form at this point. This part of the axis may be seen slightly posterior to that part of the 3rd cervical.

4. This type of film presents also the lordosis or kyphosis, if any, besides anomalies and malformations as visualized from this angle.

5. The lateral view further presents outlines of the mastoid processes, thyroid gland and often a clear outline of the condyle nearer the film. The external auditory meatus or canal may or may not appear on this film. However, when

it does it appears as a dark circle posterior and slightly inferior to the mandibular cavity.

AP Flat

This view is made with the cassette or bucky in as direct contact as possible with the patient's head and back, conforming as near as possible to the angle of the patient's neck. This angle is noted by a level on the bucky and is usually found to range from 8 to 12 degrees. Again I would like to stress the fact that the tube is angled to parallel that of the bucky, directing the central rays at right angles to the center of the cassette, bucky diaphragm, or film.

DO NOT FAIL TO ALIGN THE OCCIPITAL PROTUBERANCE AND THE FRONTAL GROOVE WITH THE CENTRAL BEAM OF X-RAYS BY ROTATING THE PATIENT'S ENTIRE BODY. This may force one shoulder to the film and draw the opposite one away from the film.

The string method is likewise practical in this view in aligning the tube with the patient. By looping the loose end of the string over the index finger of one hand (the other end of the string being fastened to the tube, tube bowl, or tube casing, depending on what type of equipment is used)

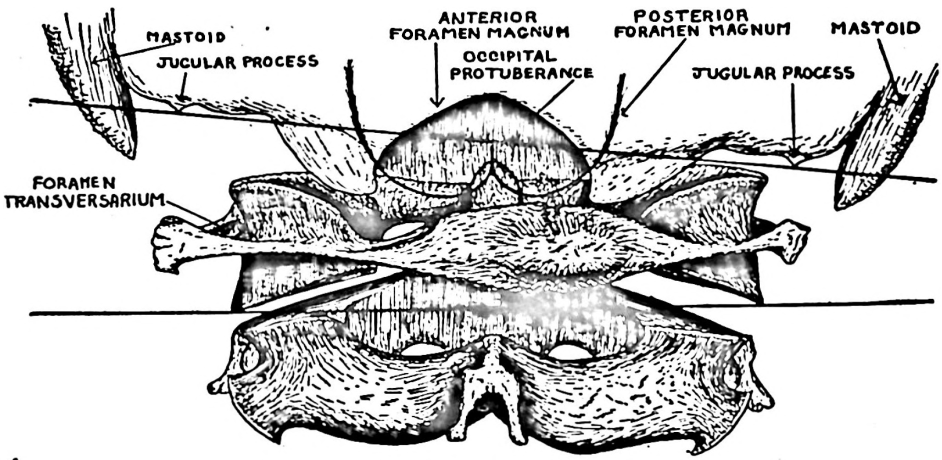


Figure No. 137
Right Low Right Wedge

and placing that finger with the string against the patient's occiput with the patient's mouth open, it will be found if the placement is correct that the string carries on slightly superior to the lower teeth or perhaps thru the center of the cork. String should be kept taut across the side of the patient's face with the finger against the occiput.

This method of alignment should produce a film revealing the condyles, anterior foramen magnum, lateral masses, posterior arch of atlas, and perhaps some vision of the anterior ring, transverse processes of atlas, odontoid of axis, inter-odontoid spaces, lamina of axis, and in the majority of cases the spinous of axis, all between the upper and lower teeth. In other words, this lineup in placement should not reveal any obstruction of the descriptive parts necessary in making the analysis from the A to P spinograph. But in the event that anomalies or malformations exist to the extent of obstructing certain descriptive parts necessary in making a listing it becomes necessary to do one of two things. Either take a nasium view or very slightly change the position of the patient's chin up or down, or the position of the tube by raising or lowering it. This of course, would change the angle of the rays driven through the mouth to the film. It should be definitely understood that better results are obtained by raising or lowering the tube rather than by lowering or elevating the patient's chin. This method keeps the patient still in the normal relaxed position and what small degree of distortion produced by not having the angle of the rays vertically at right angles to the film is very slight; therefore, it will not materially interfere when listing the film.

This spinographic view gives some indication of atlas rotation and reveals the third direction in atlas subluxation which is its laterality or more commonly spoken of as side-slip or the point of wedge, the position of the occiput at the side of point of wedge, the rotation or pivots of axis, laterality of the body of axis, as well as lateral cervical bendings, the position of the occipital protuberance relative to the me-

dian line; and the anomalies or malformations ordinarily made visible from this angle.

1. The first step in reading this type of film is to know which is the right or left side of the case as you would face the back of the individual. It is understood that you look through the film when in the reading box, from the posterior to the anterior. That which is your right is the patient's right side. This is made known by the marker placed on the film at the patient's right side during exposure, and which is your right side when making the analysis.

2. This rule determines the proper placement of the head so far as the frontal groove and the occipital protuberance are concerned. Anatomically the occipital protuberance is in the posterior center of the skull at that point. This should conform to the median line on the film, proving the frontal groove and this protuberance are in line with one another. It being right or left of the median line, proves that either placement was incorrect or that anomalies or malformations exist at this point.

3. This refers to anomalies and malformations. Practically all spinographic films reveal some difference in the size of the descriptive parts with or without exostosis and ankylosis. Such conditions are as follows: malformed occipital protuberance, difference in size and contour of lateral masses and transverse processes, bent transverse and odontoid process, incompleteness of posterior arch, cleft spinous processes but rarely an incomplete anterior ring, and others too numerous to mention.

4. Determine cervical rotation, lateral curvatures with or without rotation. Three or more adjacent segments rotating or bending in the same direction make a rotation, a scoliosis or a rotatory scoliosis. Scoliosis may or may not include rotation.

5. This rule determines the imaginary median line which extends vertically through the anterior portion of the foramen magnum as seen on the film.

Please note that properly made AP upper cervical spinographs reveal a semi-circle above the odontoid which connects both internal margins of the condyles on the film. This indicates the anterior portion of the foramen magnum. To draw such a median line would first mean drawing a horizontal line connecting both points of condyle and anterior foramen magnum as mentioned above; bisecting these two internal points of the condyles and then drawing a vertical line at right angles to the horizontal plane line through the foramen magnum.

6. To determine the rotation or pivot of axis, compare the junction of its laminae with the pedicles or outer edges of the body of the axis and then the body with the imaginary median line. Occasionally the junction of the laminae will be seen right of its own body and left of the median line. When the axis pivots or rotates left, spinous right, the body moving left may carry the spinous process or junction of laminae left of the medan line. This would not be considered a left axis—but instead a right axis, body actually left. Incidentally, the opinion is the axis should be listed before atlas, and atlas rotation before atlas laterality because axis and atlas rotations, as well as their laterality change or vary the width of the inter-odontoid spaces and spaces between lateral masses and jaw.

7. Locate the jugular processes. They appear at the base of the occiput extending downward as an osseous structure ordinarily in the form of a pointed lip although they are many times found to be quite round. They usually appear about midway between the mastoid processes and the outer edges of the lateral masses, above the tip of the transverse processes of the atlas. In most cases they appear on the film although it is known that sometimes one will not appear. Locating one jugular process draw a plane line from this point to the same point on the opposite side. This proves the tilt of the occiput and forms half of the wedge.

8. Locate the very lateral inferior tip ends of the lateral mass and draw a plane line from that point to the identical

point of the opposite lateral mass. The two lines prove the point and blunt of the wedge.

9. Determine the rotation of atlas by deductions of descriptive parts, or use the vertex view.

10. This refers to the side-slip, point of wedge, or laterality of atlas. A subluxated atlas coincides laterally with the point of wedge unless wedge lines are erroneously drawn due to anomalies or malformations and the atlas moving laterally moves up on the condyle on that side. Let it be understood that just the inter-odontoid spaces and the relative position of transverse processes and mandible do not prove the lateral direction of the atlas. However, these points are considered along with other points particularly in stereoscopic work.

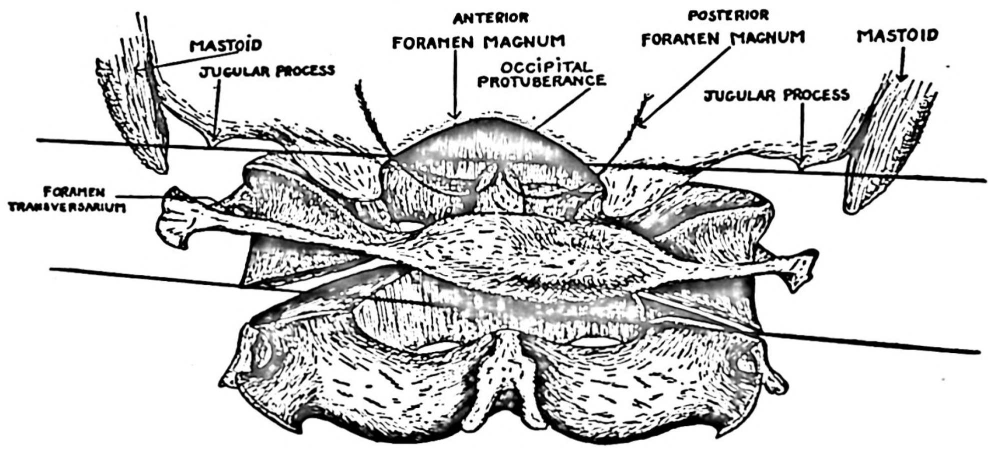


Figure No. 138
Atlas and Axis — AP View
Left Hi Left Wedge

CHAPTER 34

HOW TO DETERMINE THE ATLAS ROTATION STEREOSCOPICALLY

Though the A to P, Lateral flat or natural pictures did reveal a tremendous amount of information for the Chiropractor, it was obvious that more detailed spinographic knowledge was necessary. This was particularly true in problem or border-line cases. Therefore, research and experimentation continued in the laboratories of the Palmer School of Chiropractic. It was later proved that the atlas did rotate, either between the occiput and axis, with the axis or occiput, or both.

This rotation is actually the fourth direction in atlas subluxation and its importance is so vital when giving the adjustment that when this method is carefully studied and worked out, results increase many fold.

May I respectfully make the following remarks: To successfully practice Chiropractic, precision stereoscopic X-ray and the Neurocalometer or Neurocalograph equipment are necessary.

The stereoscopic spinographs will determine and reveal the subluxation also the approximate degree of the misalignment; that is to say, whether the adjustment to be given should favor the anterior, superior, inferior or lateral direction, or stress the atlas rotation.

The Neurocalometer will register the points of pressure which makes it possible to know when the adjustment should be given. After the recoil thrust, another Neurocalometer reading is made. This determines the adjustment.

I would like to quote a few of Dr. B. J. Palmer's remarks: "To X-ray precision-like, and adjust accordingly, shows success where before it was a failure. The length of time taken to obtain results is cut down where before it was prolonged. Pain is decreased where before it was increased and life is saved where before it was lost. Success is based Chiroprac-

Figure No. 139 — Wooden Demonstrator

tically on results first last and at all times. Can you afford to lose a single case either in death, failure or non-delivery of results? The stereoscopic spinograph makes possible the difference between failure and success, no results and good results, guess and knowledge, doubt and positiveness, theory and fact".

Spinographic film reading has become a science in itself. It is one that requires a great deal of intensive study and practice.

It is necessary that one have a thorough knowledge of Chiropractic Orthopedy in order to know certain normal and abnormal conditions of the spinal column. One could not possibly recognize the abnormal unless he thoroughly understood the normal. Knowing these characteristics makes it less difficult in applying the methods used in reading the spinograph.

There should not be any confusion when listings are made and read ASR—Right Transverse Posterior or Anterior; ASL—Left Transverse Posterior or Anterior. In no way is reference being made to the anterior arch when listings of atlas transverse processes are made either posterior or anterior. It simply means that in addition to the three directions already listed, there is a twist or rotation of the atlas. And when listing a transverse of atlas posterior, it must be understood that the opposite transverse is ordinarily anterior. Also bear in mind that the anterior transverse ordinarily travels as far anterior as the posterior and vice versa.

However, the opinion is that in rare instances one lateral mass may slightly pivot, allowing the opposite one to swing anterior. In this event a lateral curvature, of extreme nature usually exists. When this condition of atlas appears on the film it will be noted that it is at the side of point of wedge. The weight of the head at this particular point of condyles and lateral mass seems to allow far less travel of lateral mass, it remaining in a more or less fixed position. I have never seen a posterior lateral mass or transverse in this con-

dition. Mechanically, it is not possible because of the interlocking system of anterior ring and odontoid of axis.

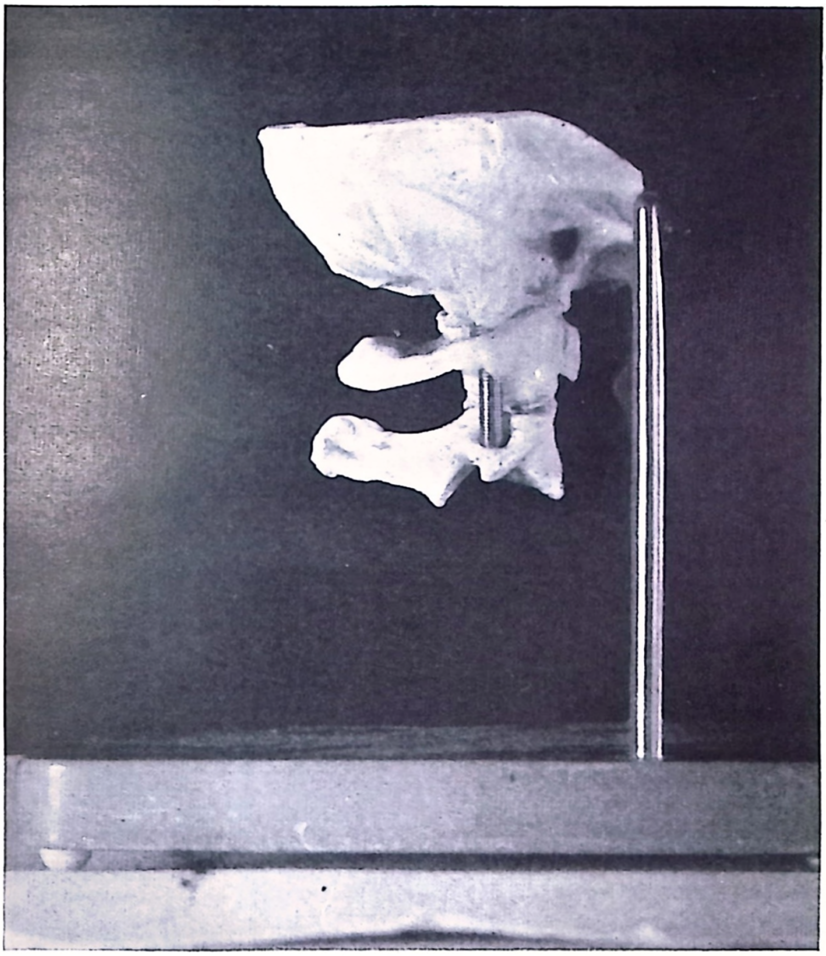


Figure No. 140
Lateral View (Matched set)

Certain definite procedures are carried on during the actual picture taking, which should be considered when analyzing the film. One should know the manner in which the patient was placed as well as the position of the tube and film in order to arrive at an absolute conclusion as to sublux-

ations, misalignments, contours, etc., It is true that a malposition of the patient and X-ray tube, or tube and X-ray film will produce on the film something that really does not

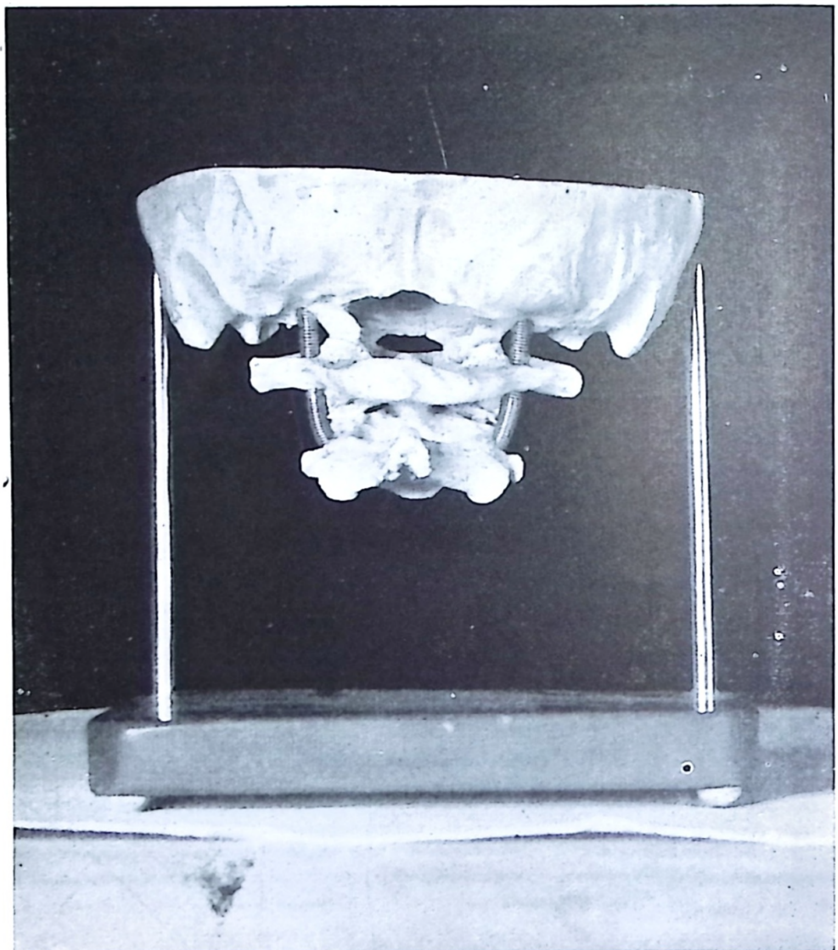


Figure No. 141
Anterior Posterior View (Matched set)

exist within the patient's spine or spinal column. So it behooves every technician to make sure the position of the tube, patient and film are correct.

It is obvious that ten cervical pictures makes a complete stereoscopic set for spinal analysis: the regular Lateral and AP flats, AP, Diagonal, Vertex and Nasium Stereos. Vertex

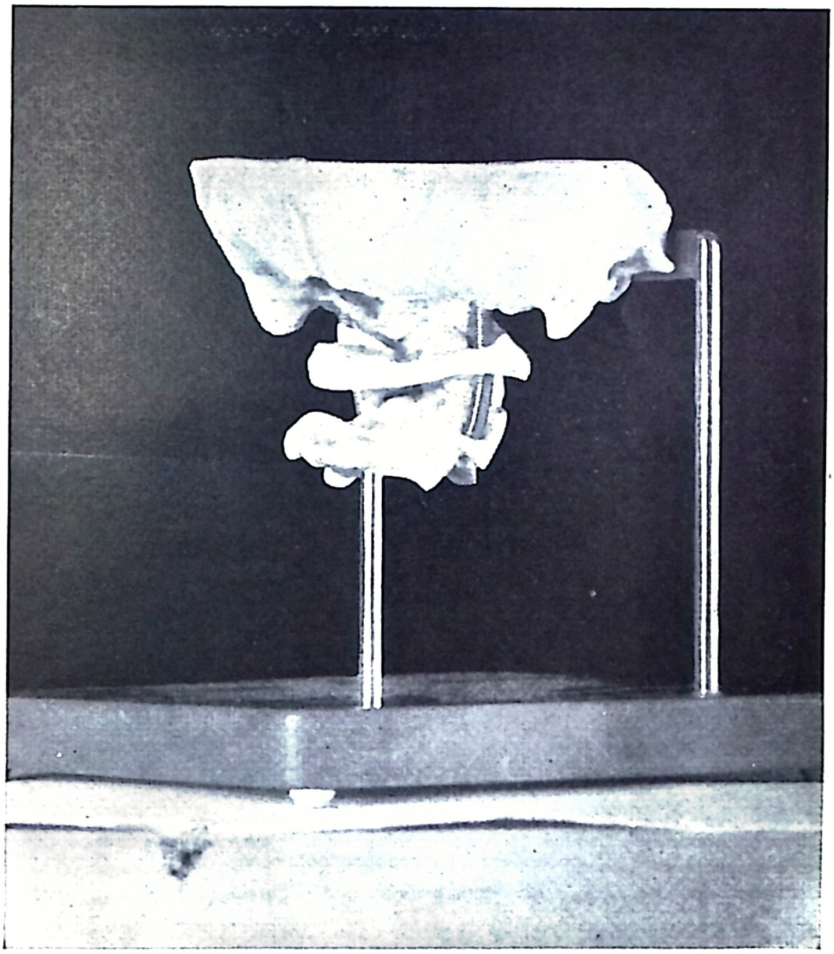


Figure No. 142
Diagonal View 35° (Matched set)

films are made from either the AP or PA directions. The anterior-posterior vertex set is known as the BP set or base posterior. The flats fairly well determine the first three directions in atlas subluxations. The stereos prove the atlas

rotation and by making possible visualization from other angles, determine the existence of anomalies and malformations not revealed in the ordinary flat or natural work.

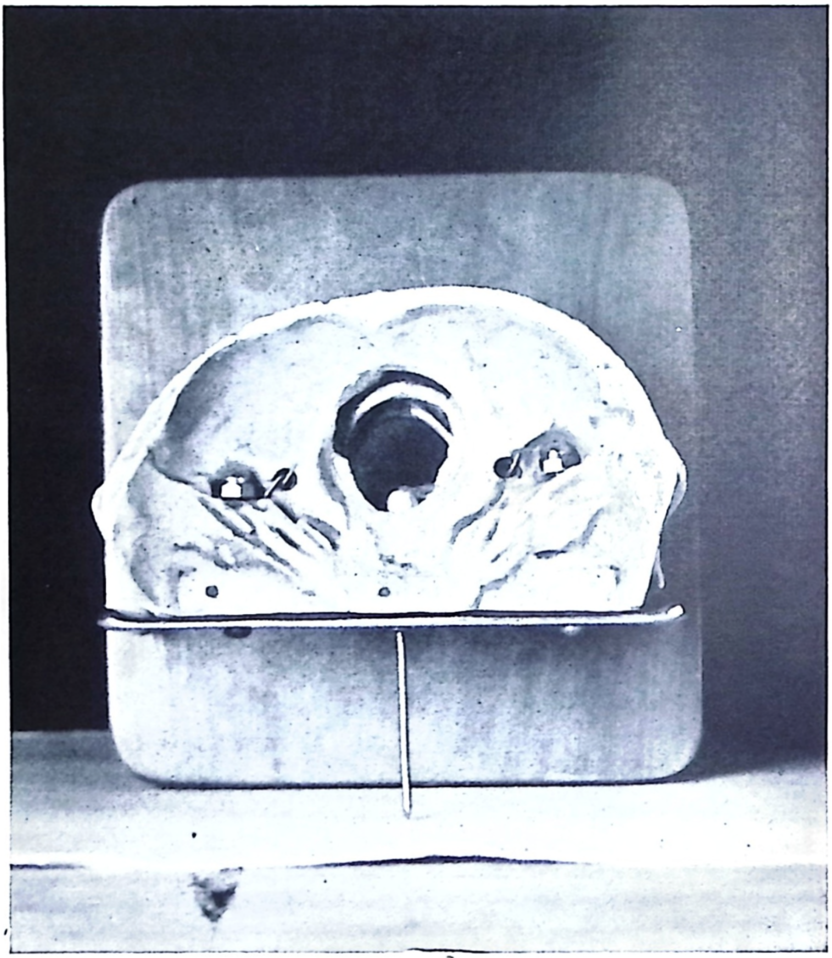


Figure No. 143
Superior to Inferior View (Matched set)

Let me repeat: To palpate and depend on its accuracy is obviously the incorrect way for the Chiropractor to proceed. This is particularly true when he deals with the upper cervical region. How could one otherwise determine the correct

position of the anterior arch and the atlas rotation unless he spinographed? Remember the transverse processes, in the majority of cases actually vary in size and are often abnormally bent. For instance: the atlas may be superior at its anterior and the transverse process on the side of laterality point either upward or downward. So the relative position of its tip and the rami could not possibly be of much value in palpation; that is, when attempting to determine superiority or inferiority not mentioning anteriority, laterality or rotation of the atlas.

Bear in mind that accuracy in the strictest sense of the word should always be the first thought in spinographic procedures. The abnormal or unnatural rotation of the patient's head and cervicals must be obliterated in the placement. To know the abnormal or unnatural rotation in the carriage of the patient's head is made possible when the technician first comes face to face with the patient. To actually see the occipital protuberance corresponding to a median line on the film is to know that precision was carried out so far as placing the patient is concerned.

Incidentally, the imaginary median line is that line extending vertically through the center of the anterior portion of the foramen magnum. It is a very important factor when attempting to determine either atlas or axis misalignment.

To mechanically draw such a plane line, locate an inferior internal point of the condyle. Bisect these two points and draw a vertical line at right angles to the horizontal line connecting the two points of condyles.

To verify the rotation of the head, if any, you will note that when the occipital protuberance is left of the median line, the mastoid process on that particular side is very often more prominent. It appears larger although it will lack detail, contrast and its lines will be more or less fuzzy. This is the result of that particular part moving away from the film. Naturally the mastoid process on the opposite side of the median line moving towards the film becomes smaller as compared with the opposite one; with more contrast and

detail and its outlines sharp. Should anomalies exist between the two mastoid processes, referring now to the one being actually larger than the other or that the true anatomical positions are not identical, this rule may not be consistent. Incidentally, I have previously mentioned other points indicating head rotation. However, under ordinary circumstances one should not have any difficulty in determining whether or not the head was abnormally rotated in placement or whether the occipital protuberance being one way or the other of the median line is an anomaly. When such is the case the occipital line is very irregular.

I should like to stress here the importance of eliminating motion for motion appearing on the film makes it valueless. Such films will not properly fuse in the stereoscope. Usually two outlines of structure will appear rather than just one. If motion was very slight, only one line may appear but instead of being thin, sharp, and clean cut, it will appear broad, fuzzy and indistinct.

To simplify and to avoid confusion when attempting to arrive at a definite stereoscopic cervical conclusion it is advantageous to have at your command a matched occiput, atlas and axis set. As a matter of fact, I should consider this as necessary to the Chiropractor as surgical tools are to the surgeon.

To attempt to duplicate from the film the position of the cervicals in question with a matched set may cause one to alter the listing. The point I am trying to convey is that certain points indicating a certain direction may not appear so prominent to you by film visualization as they would when studying the possible misalignment made by manipulating the segments of a matched set. This should be a part of the Chiropractor's equipment.

Theoretically, the anatomical position of the tubercle of the posterior arch of atlas should be the center of that particular neural ring at the posterior. This tubercle is determined by its irregularities, its size relative to its adjacent osseous structure of the posterior arch and the density of

this area. Because this tubercle is of conical shape, of a heavier structure, its middle section will often offer more resistance to the X-rays and in that event it will appear light to white on the X-ray film. It may be well to remember here that light to white on the exposed film equals resistance, while dark to black equals little or no resistance offered to the X-ray. Further mention may be made that one will often see a small groove at the superior border of this posterior tubercle and ofttimes a rather faint light line on the

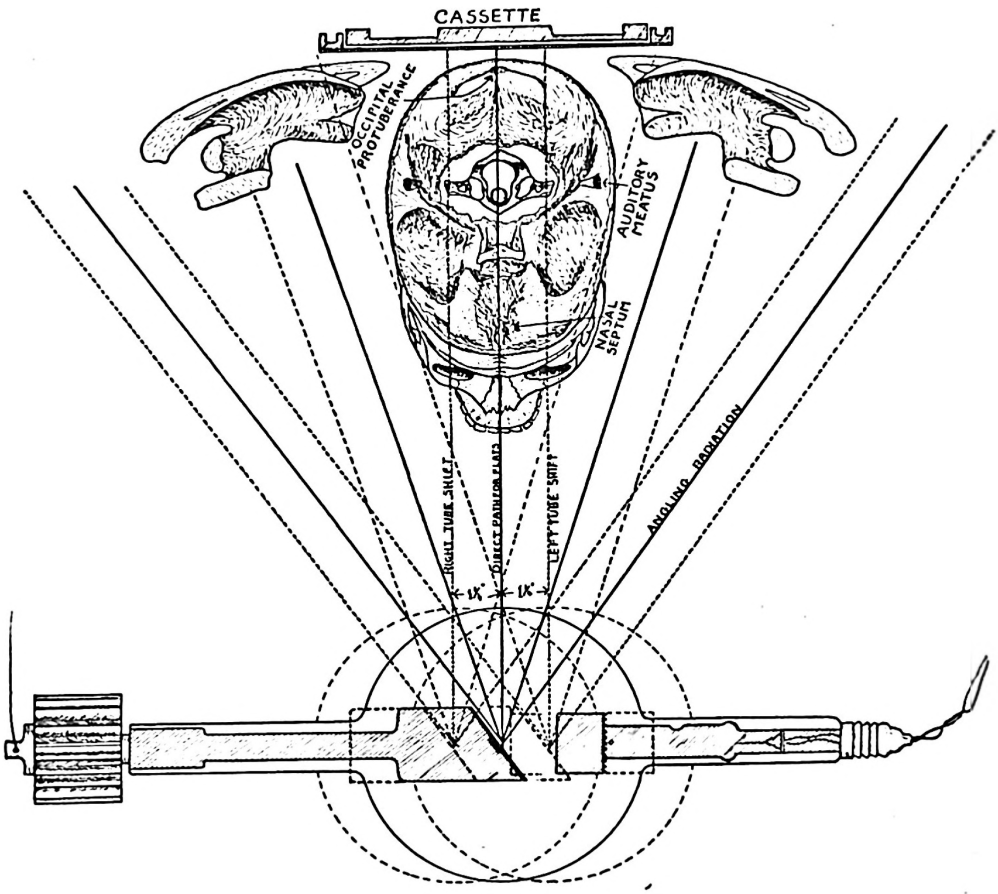


Figure No. 144
AP View showing Anatomical positions and path of direct rays for AP Flat and AP Stereo Shifts

film extending down from this point over the posterior portion of this tubercle. This indicates the osseous union of the lamina or posterior arch of the atlas at the posterior.

When the atlas rotates, this tubercle must change its position relative to the median line. As the atlas rotates with the right lateral mass and its transverse process posterior or nearer the film, the tubercle ordinarily moves left of the median line. This being true, the left lateral mass and its transverse process will have gone anterior or further away from the film. On the other hand, if this tubercle moves right of the median line, the left lateral mass and its transverse process will then be posterior or nearer the film.

The groove for the vertebral artery and the first pair of spinal nerves as seen on the upper half of the posterior arch near the lateral mass of atlas is always more prominent on the posterior side of atlas rotation than on the anterior side. Its outline becomes more clear and distinct as it moves towards the film. The reason the anterior side is not as clear is due to the fact that the posterior arch begins to overshadow this groove as it moves away from the film. Perhaps a good way to remember the position of the posterior tubercle of a rotated atlas in relation to the median line, is that the tubercle moves correspondingly with the anterior transverse process. In other words, when a right transverse moves anterior, the tubercle moves right of the median line. If the right transverse moves to a posterior position the tubercle then moves left of the median line.

Assuming that all descriptive parts are symmetrically developed, when the atlas rotates with the right lateral mass posterior, the right transverse process will appear longer, and somewhat narrower than the left and more clearly outlined. The left transverse becomes wider because it moves away from the film and shorter because it is being overshadowed by the left or anterior lateral mass. Outlines then appear fuzzy more or less indistinct. The posterior transverse becomes elongated or distorted because of its angling position relative to the path of X-rays. Per-

haps a good way to demonstrate this is to note how the density changes when you place your finger or a pencil over a piece of white paper. As the pencil or finger is placed in close proximity to the paper you will note its shadow is nearly the same size and black, yet there will be a clear outline of the object. As you raise the object off the paper the density changes, the shadow becomes slightly larger, not so dark with fuzzy outlines.

The posterior lateral mass will appear smaller than the anterior one with its internal margin nearer a parallel plane with the direct rays. It usually appears lighter as well because of the increase in resistance to the X-rays due to its relatively greater depth. Its outlines appear sharp and clean cut and what would be the junction of the posterior arch and lateral mass usually stands out white.

The anterior lateral mass appears larger on the film with outlines quite fuzzy, not so sharp and distinct. Here the density changes again, due to less resistance, but making a much darker internal lateral mass area. To illustrate the change in density, think of the lateral masses or their superior articulations as being concave with a more or less crescent contour. These masses appear on the film as being longer from posterior to anterior than from side to side. Anatomically, the two lateral masses should appear on the film the same size, the same shape and in the same relative position with the same amount of density or black and white appearance providing of course, precision is carried throughout the placement of patient, tube and film. If the distance from the posterior to an anterior border of its superior articulation (when the transverse is posterior) is one inch and its distance from side to side is one-half inch, it would only offer a certain amount of resistance to the X-ray. Therefore, the object would assume a certain light colored appearance on the film.

When the atlas rotates, the density generally changes due to the difference in resistance to the rays at a given point. So when a transverse moves anterior in rotation the

rays penetrate the lateral mass from side to side rather than from end to end. This distance being approximately one-half the distance from end to end causes less resistance offered to the X-ray, and again the density changes, giving this particular lateral mass a dark appearance on the film. In other words, the anterior lateral mass should have the largest darkened internal area.

The tubercles for the attachment of the transverse ligament are located on the internal portion of each lateral mass near its central inferior area. They are not always visible on the film. But when they are visible, the one situated on the posterior lateral mass appears larger while the opposite is true of the one on the anterior lateral mass. When it appears on the posterior lateral mass on the film one may note its profile clean cut and its color dark. This is because it stands out slightly away from the internal surface of its lateral mass offering less resistance. The anterior one becomes embedded in the lateral mass itself and is seen as a part of the internal surface of the lateral mass. Consequently this point is not seen on the anterior lateral mass.

In a further attempt to prove the rotation of the atlas imagine a line drawn vertically through the tubercle of the posterior arch; two other lines drawn vertically at a lateral border of each lateral mass. The distance between the center line and the line drawn on the posterior side of the rotation will be greater, indicating posteriority, while the opposite space will be narrower proving anteriority in rotation. Comparison of points for detail and sharpness of outline materially aids in knowing which is nearest the film and which is farther away from the film. The parts moving towards the film are posterior while those moving away from the film become anterior. The posterior points are usually smaller, better outlined, while the anterior points become larger, unless overshadowed by other descriptive parts.

It is understood that when patients are properly placed for either flat or stereoscopic AP view of the cervical region,

there will be revealed on the film a semi-circle over and above the odontoid of the axis.

This is usually visualized through the base of the skull and is commonly known as the anterior portion of the foramen magnum. To think of the normal, anatomically, these lateral masses should evenly divide themselves within this semi-circle area.

Figure No. 145
Atlas and Axis
Showing Anterior Foramen Magnum

When the atlas rotates with the left lateral mass anterior, the right, of course, posterior, the left mass will appear within the foramen magnum area more than the right. This may or may not be indicative of a right side-slip. So, naturally it is not a wise thing to use the foramen magnum area to definitely verify the side-slipping of the atlas, unless consideration is first made of the atlas rotation.

For example, in a right point wedge or right side-slip, providing there is little or no rotation of atlas, the left lateral mass should appear within the anterior portion of the foramen magnum area more than the right. But when the atlas rotates with the right transverse process anterior, within a right side-slip, the right lateral mass will move into the foramen magnum area, as seen on the film and the left will move out. There would then be a contradiction to such a method used in determining a right side-slip if only using the foramen magnum as a matter of verification.

IT MIGHT BE WELL TO AGAIN REMARK THAT THERE IS ALWAYS DANGER OF INCREASING THE ROTATION OF THE ATLAS WHEN ATTEMPTING TO ADJUST IT UNLESS THE SPINOGRAPH IS POSITIVELY ADHERED TO.

Providing the superiority of the atlas is not exaggerated or the atlas is not tipped laterally or that the head is not abnormally rotated during the process of exposure that portion of the atlas appearing beneath the posterior arch will appear larger on the posterior side and smaller on the anterior side. Such appearance on the anterior is due to this part of lateral mass being overshadowed by the posterior arch and articulation of axis on that particular side.

Before using this rule it is necessary to consider the symmetrical development of both lateral masses.

The transversarium foramen are two in number located in each transverse process of the atlas. Their size is somewhat smaller than the ordinary lead pencil. The lateral mass ordinarily forms the internal wall of this foramen. They

appear quite circular in shape. Under anatomical conditions with perfect alignment, these foramen would be revealed on the film, having the same size with sharp outlines. When the atlas rotates the spinograph reveals the one having gone anterior gets larger in size but its internal border becomes overshadowed by that lateral mass. Its outline becomes fuzzy, its depth is reduced on the film and because it becomes overshadowed, it then is not true to anatomical form.

The one moving posterior or towards the film tends to get smaller. It ordinarily assumes complete anatomical contour of its superior portion. More depth is seen and its outlines become sharp and clear. This is due to a closer contact with the film. There is no over-shadowing by the lateral mass which makes it possible to see the complete superior contour. The amount of the tip of the posterior transverse made visible on the film largely depends upon the degree of atlas rotation.

Providing there is not a great deal of inferior tipping of the atlas towards the anterior and the anteriority is not exaggerated, one will see on the properly exposed film a certain amount of both superior axis articulations superior to the posterior arch of atlas. When the right transverse moves anterior with the left transverse posterior, more of the axis articulation will be seen on the side of the anterior atlas transverse — a lesser amount on the side of the posterior atlas transverse. This is all visualized just above the posterior arch of atlas. Should one lateral mass pivot allowing the opposite one to move only anterior, it is quite likely that all vision of superior axis articulations above the posterior arch will be obliterated. However, the apparent size, shape and position of the 1st neural ring, as seen above the posterior arch and compared with the posterior superior portion of the axis may be indicative of a rotated atlas. Comparison of interodontoid spaces is of little value in determining the side-slip of atlas unless atlas and axis rotation as well as laterality are taken into consideration. Anatomically both spaces should be the same width. When the axis rotates

right, the tendency is to decrease the right interodontoid space and increase the left and vice versa. This is due to the fact that the odontoid process of axis is not circular in its development. It is thicker from posterior to anterior than from side to side. When the atlas rotates with the right transverse anterior the tendency is the same in that the right interodontoid space decreases and the left increases. So in using the interodontoid spaces as a possible point to determine the atlas rotation, consideration must first be made of the side-slip and whether or not there is any rotation or laterality of axis or malformation of the odontoid.

With lateral masses nearly the same size and shape, a lateral overlapping of axis and lateral mass may or may not appear on the film. When the right transverse moves anterior it appears that the right superior articulation of axis projects laterally to the inferior posterior tip of the lateral mass. Of the posterior right transverse such appearances remain the same but such depth as maintained in stereo procedures produces certain shadows against the posterior portion of axis inferior to the posterior lateral mass. This tends to prove that the right lateral mass has moved posterior or to a position directly over a portion of the 2nd neural ring—right side. Of the opposite side, in this event, more of the superior surface of the left axis articulation is visible.

The anterior half of the fovea dentalis articulation is concave. In examining a specimen you will note this surface quite circular in shape, so indicated by its rim. This rim being slightly heavier in structure appears on the film as a white circular line with its concave portion slightly darker. When the right transverse moves anterior the lateral portion of this rim is always obliterated by the odontoid process. But when the transverse moves to a posterior position it is quite likely that it will be seen on the film; however, a greater degree of side-slip offers more visibility of this particular point.

Though the position of the posterior tubercle of posterior arch of atlas relative to the median line plays an important

part in determining which transverse is anterior or posterior, it is not an iron-clad rule. For when the posterior atlas rotation is slight on the side of laterality and the point of wedge and anteriority is exaggerated, the posterior tubercle may be found on the side of the median line corresponding to the point of the wedge. This is a rather rare occurrence but such appearances are visible on the film.

Placing the AP and Diagonal stereoscopic films in the stereoscope

When placing the films in the stereoscope for the ordinary AP and Diagonal sets, the film marked R indicating the right tube shift goes in the left box with the letter R or the marker towards you. The film marked L indicating the left tube shift goes in the right box with the letter L or the marker away from you.

The prisms or mirrors in their assembly should be forced away from you as far as possible and when looking into the mirrors you will note the two images or the two films. Then the film marked R is visible with your left eye and the one marked L is visible with your right eye.

Then locate some prominent and similar points or structures on both films such as (in cervical work), the odontoid process, the occipital protuberance as seen on the film at the base of the occiput by white lines indicating an inverted V, fillings in the teeth, or the teeth themselves, lateral masses, spinous of axis, etc.

Visualization is then made in the mirrors and same are tilted laterally either right or left until these two particular points of structure level absolutely horizontally.

By then rotating the mirrors in the proper direction and at the same time drawing the mirror assembly to you slightly you will focus and fuse the two films viewing the marker in the mirrors at your right side.

It is necessary in the construction of a stereoscope, at least the type as shown in this text, to have both stereo illuminators the same distance from the center of the mir-

Figure No. 146
Diagonal Cervical

rors. So before attempting to fuse the films it is necessary to know that both boxes are located the same distance from the center of the mirrors on either side. Ordinarily these illuminators are movable and to decrease the distance not only tends to throw the films out of focus but has a tendency to increase the size of the object and vice versa should attempt be made to increase this distance. Further the ordinary stereoscope makes possible the rotating of the in-

dividual box towards you and makes possible depth visualization from a slight degree of angle.

Hence, depth and third dimension are made possible.

Diagonal Stereos

As the result of continued research and experimentation another view was decided upon. It was found very valuable because it gave further evidence of the anomalies and malformations not visible on either the flat or AP stereos. As

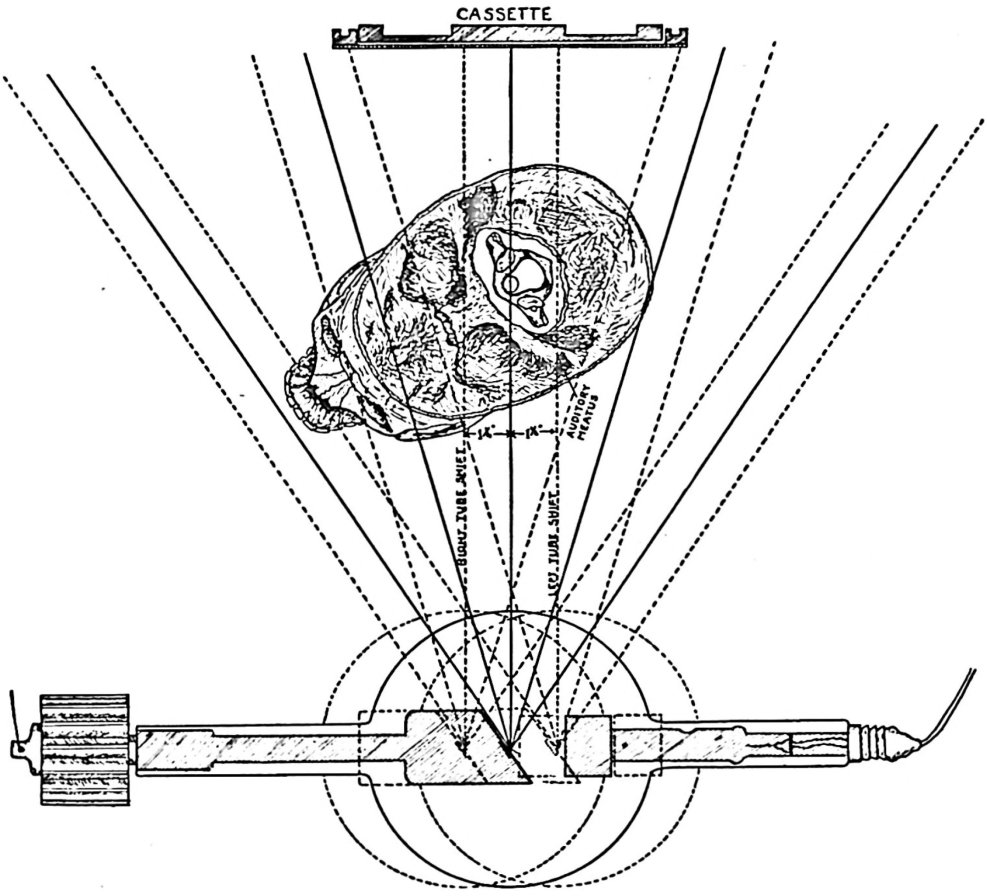


Figure No. 147
Showing Anatomical positions and direct path of Rays for 35° Diagonal Stereo Shifts

the name implies, this view was called Diagonal stereo because of its angled position relative to the film and tube.

LET IT BE DEFINITELY UNDERSTOOD THAT DIAGONAL VIEWS CORRECTLY MADE ARE IMPORTANT. In addition to verifying the rotation of atlas as previously seen on the AP stereo films, this type will reveal the approximate amount of anteriority, and gives one a slant on the anomalies and malformations from another angle besides adding additional information on posteriority, anteriority, superiority and inferiority.

Ordinarily, Diagonal cervical stereoscopic films are made from one side only. However, this side is determined by the manner in which the technician conveniently proceeds in his office. The exception to this would be in cases of pathology, trauma, and fractures or dislocations, either partial or complete. In that event the side on which the suspected condition existed should be in direct contact with the film and then it would be wise to X-ray both sides.

If the film is placed at the patient's right side with either the film in direct contact with the patient's head and neck or the film or cassette resting on and against the tip of the shoulder, the rays are directed from left to right, and vice versa when the film is placed on the left side. Whichever side is decided upon, the central beam of X-rays is directed nearly in line with the external auditory meatus or canal. This causes the rays to penetrate anterior to one mastoid and posterior to the other.

May I again repeat that the placement of patient is either from a 35 or 45 degree angle from a true lateral position towards the tube. The difference in angulation seems to be only a matter of opinion. In other words, if the film was placed against the patient's right shoulder to determine a 35 or 45 degree angle, the patient should be rotated towards the X-ray tube which in this event would be at the patient's right side and vice versa when the film is placed at the patient's left side. The following points are based on a 35 degree angle.

To make a scientific analysis of the diagonal stereoscopic views, necessitates knowing the normal occiput, atlas, and axis and their articulations and to have a clear conception of the distortion presented by the angled posture of the patient and the direction in which you are reading the film. Naturally viewed from a posterior lateral angle similar structures are visualized from a slightly different angle, though structures which are farther away from the film will appear larger, if their view is not obliterated, in all dimensions in exact ratio as they move away. Further, their outlines will not appear as clear and distinct as when they move nearer the film. Thus you see the right mastoid if the patient's right side is closer to the film from a more posterior angle than that of the left. The left mastoid should appear larger than the right because you are viewing it from a more lateral aspect and too, because it is farther away from the film. The same is true with condyles and lateral masses.

It is unwise to attempt to analyze and arrive at any definite conclusion until the following five factors have been considered:

1. At which side of the patient is visualization being made. Incidentally, one may know which side of the patient he is looking at on the film even though he did not actually witness the exposure. When the marker rule is carried out in placing the marker on the film at the patient's right side, the anterior ring pointing towards the marker is indicative of the film having been placed at the patient's right side. When the spinous processes point towards the marker you may readily know that the film was placed at the patient's left side.

2. At what angle is visualization being made. This of course, is vitally necessary because all points are based on a 35 degree angle.

3. Whether or not there is any rotation of axis. This information was determined when reading the AP flat and AP stereos. When this is not known it may or may not

cause one to alter such listings of lateral mass and transverse in rotation.

4. The point of the wedge as seen from the AP flat and AP stereos. When for instance the point of wedge is left and reading the right side of the patient in diagonal work points would be reversed.

5. Anomalies and malformations as seen from a different angle.

The following points are based on a 35 degree angle and are in favor of a posterior right transverse.

Assuming no rotation of axis, anomalies, or malformations are present of either atlas or axis, the posterior inferior margin of the right lateral mass will extend posterior to the superior margin of the right axis articulation. Naturally, this reveals a part of the superior axis articulation on the right side anterior to the anterior edge of the right lateral mass. The appearance of the left or opposite side would be just the reverse.

The right lateral mass in moving to a posterior position will more or less completely over-shadow the odontoid process of axis, unless of course, there is some malformation or anomaly of this point of axis, particularly when the odontoid actually bends towards the posterior. Such a malformation of the odontoid is rather a rare occurrence although it sometimes appears on the film. I have not seen many odontoid processes actually bending towards the anterior. The degree of rotation of atlas causes more of the odontoid to be overshadowed.

The left lateral mass rotating toward an anterior position reveals the anterior portion of that lateral mass diagonally anterior of the odontoid, naturally the odontoid then overshadows that part of this lateral mass on the film.

The right transverse process appears more prominent with its tip end visible. However, in extreme posterior right transverse processes the transverse process appears quite short and in some cases its outline is not clearly visible. In that event, you see the transverse as a sort of white mass

ahead of the lateral mass. In other words, this appearance of transverse process is revealed directly between the interpreter and the lateral mass rather than diagonal laterally away from the lateral mass. The amount of the tip of the transverse process visible depends largely on the degree of the posterior rotation of the atlas.

The transversarium foramen will appear posterior to that of the axis. Anatomically speaking the transversarium foramen should be directly above one another coinciding with the cervical spinal bend. When they are not, the one in question breaks the continuity of the arc. It will be readily seen then by forming a more or less vertical imaginary line through the transversarium foramen of atlas and the same point of axis, the atlas line will be posterior to that line of axis when the right transverse of atlas moves posterior.

The same method may be used when comparing the center of the groove for the first pair of spinal nerves and artery with the pedicle of axis. These two points hold the same relation to one another as the transversarium foramen, anatomically speaking. So when the right transverse is actually posterior this point of posterior arch will be found posterior to a line through the pedicle of axis.

The spinal grooves of the posterior arch are formed by the posterior arch itself and the lateral masses. To X-ray an atlas not rotated with proper placement of X-ray tube, the anterior wall of this groove would be visible. The posterior wall would not be visible. So naturally when seeing the atlas from a 35 degree angle, more of this groove will become visible on the film as the degree of posterior rotation of atlas is increased. In other words when the right transverse moves posterior more of the actual contour of this groove is made visible.

Normally, there is some space revealed on the film between the condyles and lateral masses. This of course, is of a cartilaginous nature. It appears on the film dark to black, indicative of the fact that less resistance is offered to the

X-rays at this particular point. As the atlas rotates, it will be seen from the angle in which Diagonals are made that this space increases at the posterior or decreases as the transverse process moves either anterior or posterior respectively. When the space just mentioned increases on the left, it decreases on the right and increases on the right at the anterior.

When the atlas rotates with the right lateral mass posterior, the very posterior superior point of left lateral mass moves diagonally anterior from the very posterior point of condyle on left side. This point of lateral mass on the right side moves posterior to the very posterior point of right condyle. When the right transverse is found anterior, the posterior superior point of left lateral mass moves posterior whiie this point of lateral mass on the right side moves diagonally anterior from a posterior point of right condyle.

Ordinarily the left transverse process of atlas is not visible on the film when the right transverse moves towards a posterior position. This places the left transverse beyond or in front of the left condyle and lateral mass and due to the fact that this particular descriptive part offers less resistance to the X-rays, it does not become visible when penetrating condyle and lateral mass towards this point. The total amount of overshadowing here depends upon the degree of inferior tipping of atlas at the anterior as well as the degree of atlas rotation with the right transverse posterior—the left transverse anterior.

At first glance, a general scrutiny of the entire cervical region may give one an idea of the position of posterior tubercle of the atlas and the spinous process of axis. You will note, on the diagonal film, a sort of oval shaped darkened area at each spinous process as well as the posterior tubercle of atlas. This in reality is a cross-sectional view of the lamina on the opposite side or that side nearer the tube. By comparing this area with one another, when a good quality film exists, the one analyzing the film may get an idea as to whether this point of posterior arch is between the spinous

of axis and the interpreter, or whether the spinous of axis is between the posterior tubercle of atlas and the one viewing the film. This is of course, not an iron-clad rule but just another point to consider in problem or border-line cases.

It is not uncommon to see the junction of the anterior ring and lateral mass on the film when the right transverse moves anterior. This is seen on the film beyond the posterior outline of the odontoid. In other words, the odontoid in this event does not overshadow this part of atlas looking at it, of course, from a 35 degree angle. But when the right transverse moves posterior, then it is quite likely that this point of axis will move anterior to the odontoid process and the result is that the odontoid will overshadow this portion of atlas.

The fovea dentalis articulation assumes two articular surfaces — one in the anterior ring which is concave and the other on the anterior part of the odontoid process of the axis which is convex. Due to the fact that anteriority is more or less present in atlas subluxations, this space naturally increases. From an anatomical point of view, with correct placement of tube, object, and film, this space or any of the descriptive parts would not be visible in the A to P view on the film. If the atlas side-slips with no rotation whatever, with everything else being equal, a lateral portion of the anterior half of the fovea dentalis articulation would become visible. This is true of the A to P view when the atlas transverse moves to a posterior position at the side of the point of wedge. In this event, as the anteriority increases a greater amount at this point is made visible. Nothing is seen of the posterior half of this articulation except perhaps when the axis is greatly rotated towards the posterior transverse, when such location of transverse is at the side of point of wedge.

In diagonal views, these parts of dentalis articulation are always more or less visible and they form a sort of V viewing them at the 35 degree angle. As the right transverse moves posterior, the size of the V decreases. When the same

transverse moves to an anterior position this wedge increases. At that time you will note more visibility of the white line indicative of the rim of this half of the fovea dentalis articulation. The degree of anteriority increases this appearance while the rotation of axis increases or decreases this appearance.

The diagonal view determines a more correct amount of anteriority present than with the flat or natural film. The fovea dentalis articulation of the anterior ring will appear on the film with a white circular line as the rim of this surface with a darkened center. However, this is not necessarily the exact center of this articulation but more of a cross-sectional view of the anterior ring adjoining the anterior tubercle. To note the distance from this center to a vertical line at the anterior surface of the odontoid will indicate the approximate amount of anteriority or abnormal space between the odontoid of axis and anterior ring of atlas. This incidentally is the first direction in atlas subluxation.

MAY I AGAIN STRESS THE NECESSITY OF KNOWING THE PREVIOUSLY MENTIONED FIVE FACTORS BEFORE ATTEMPTING TO ANALYZE DIAGONAL STEREO FILMS.

Vertex Stereos

Intimate study of the shape, contour, and depth of tissue of the occipito-atlantal area continued, will reveal consistently dissimilar development not only of each half of the structures themselves, but of the descriptive parts as well.

Attempts were made to spinograph these various parts from still a different angle. It was found that this view made possible further facilitations in observing and comparing alignments of the articular structures and their surfaces.

This type of X-ray was then added to the stereoscopic spinographic set. It was called Vertex, meaning the top or crown or the greatest distance from the base.

It is obvious that third dimension in this work reveals more definite and long sought information than either the

A to P or Diagonal stereo sets. However, it must be thoroughly understood that this type of film alone will not offer all the spinographic evidence necessary. OTHER VIEWS MUST BE INCLUDED.

Such a procedure necessitated additional accessories in order to do the work in a precision-like manner. Naturally, this added to the initial cost of the Chiropractic spinographic equipment. But the knowledge gained more than offset this extra expense. At any rate this way of working is certainly a progressive step toward Chiropractic film analysis.

Vertex procedures are comparatively new in Chiropractic and deserve the right of criticism. Therefore, there are many ideas as to what view in this work is better and what sort of technic should be employed. Regardless of all this, absolute safety to all patients must be efficiently carried out. An overdose of X-rays in this type of procedure will in all probability cause the patient great injury. This may or may not promote a malpractice suit. As a matter of fact, an overdose of radiation in any part of the body may be harmful to the patient. However, the reason the safety precautions in Vertex work are emphasized here is that the head will not stand the amount of radiation that other parts of the body will. As mentioned previously, the body limit is 1200 and the head limit is only 900 Milliampere Seconds.

When such safety measures are thoroughly and properly employed then the correct way to proceed in Vertex work is the method which produces and reveals the least amount of distortion and a better quality film, referring now to machine technicalities.

In this work precision must be carried throughout. Distortion then as far as elongation is concerned plays little part in this view. To attempt to read a Vertex stereo set, where the head is not perpendicular with the vertical center of the film would in all probability be a waste of energy. Such areas could not be read correctly. So it behooves the technician to spend as much time with Vertex placement as he would with other types of spinal stereos. The occipital

protuberance and frontal groove must be in perfect alignment with the direct rays. The ocular orbits should appear on the film at the very top. This will allow plenty of room to see the occipital protuberance at the lower border of the film.

When using the supine posture for this type of work, the patient is so placed on the table to allow the head to tilt back with some sort of arrangement for holding the film or cassette. This of course, allows the chin to elevate. The tube is placed at the anterior directing the rays posterior inferior to the lower jaw about in line with the hyoid bone. By taking a lateral view with another machine with the patient in this placement, it will prove that distortion exists between the occiput, posterior arch, and spinous of axis.

It is the opinion Vertex views are made more satisfactorily in the upright sitting posture with the film at the anterior and the tube at the posterior directing the rays anterior inferior. If placing the tube at the posterior, directing the rays anterior inferior bisecting the point of mastoid, the film or cassette may assume two different angles; first, the chin chest position; the other, the lower border of film contacting the patient's chest with the opposite end lowered approximately three inches from the patient's chin. The first method allows the film or cassette to assume a 15 degree angle from a vertical plane line while the tube tilts at about a 30 degree angle from the same vertical plane line. The other method, with the film inferior to the patient's chin, the film and the tube are usually on the same parallel plane, or nearly so. In either case distortion is slight. Perhaps a better quality film may be obtained using the chin chest contact because the film assumes a position nearer the object.

REMEMBER THE MARKER IS PLACED ON THE FILM AT THE PATIENT'S RIGHT SIDE.

However, it is obvious that further check may be made in atlas rotation not mentioning the existence of anomalies and malformations when visualized from this angle.

This type of film will reveal the area of the frontal groove

and portions of the frontal sinuses, orbits, maxillary sinuses, the nasal spine, palate bone, rami, basilar process, in fact a general inferior appearance of the atlas and condyles. Also the odontoid is revealed, a faint outline of the body of the axis, 1st and 2nd neural rings, and occasionally the 3rd neural ring becomes visible, with the occipital line and occipital protuberance clearly outlined on the film.

Figure No. 148
Vertex View

In placing the P to A vertex films in the stereoscope, the one marked R goes in the right box with the marker away from you and the one marked L goes in the left box with the marker towards you. They are fused like the ordinary stereos. The interpreter will see the marker at his right side which is in reality the patient's right side. Readings are then made as if viewing from the posterior. When vertex films are placed in the stereo boxes with the right film in the right box with the marker towards you and the left film in the left box with the marker away from you, readings are then made from the anterior, visualization then made inferior to the chin. What is the patient's right is in reality the interpreter's left and vice versa. Remember if A to P views are made, they are placed in the stereo boxes like other ordinary A to P stereo films.

In reading this type of film, first form an imaginary vertical plane line extending from the frontal groove down through and parallel with, the nasal spine through the palate bone, and foramen magnum, in line with the occipital protuberance. Then form an imaginary, horizontal plane line through the atlas bisecting the transversarium foramina. Anatomically, these two lines should appear at right angles, providing anomalies and malformations do not exist and when precision is carried out. When a rotation of the atlas exists these lines are not at right angles. When the entire atlas shifts laterally, towards the point of one jaw, taking into consideration any head tilt and rotation, it is indicative of atlas laterality. When the atlas rotates with one transverse moving high towards one jaw that is obviously the anterior one.

In viewing the contour of the neural rings, further consideration of the axis and its relation to the atlas may be made when viewing this type of film, providing of course, technic is sufficiently good and proper placement is carried out. One will note whether or not the atlas and axis have rotated oppositely, whether the two have rotated approximately the same degree in the same direction or whether

one assumes a much greater degree in rotating the same direction. This may or may not cause the axis to be adjusted.

With the axis normal, in so far as anterior or posterior tipping is concerned, one may get an idea of the amount of anteriority of atlas revealed by this type of film. This is seen by the black space on the film, between the anterior ring and odontoid of the axis.

This type of work is always carried on in the same precision-like manner, with absolute caution for the safety of all patients.

BEAR IN MIND THAT ALL POINTS MUST BE CONSIDERED, ADDED IN FAVOR OF AND AGAINST, THEN MAKE PROPER DEDUCTIONS BEFORE ATTEMPTING TO MAKE A LISTING.

By the use of the spinograph you will have readily seen just how to contact the rotated superior or inferior atlas in order to make the adjustment, whether the contact is made anterior to the anterior transverse, torquing to or away from you or whether it be posterior to the posterior transverse with the proper torque. However, one must see to actually know which is the proper contact to make and the line of drive to deliver.

CHAPTER 35

QUESTIONS AND ANSWERS PERTAINING TO X-RAY TRANSFORMERS, CONTROLS, ETC.

Question — Can either the alternating or direct current be supplied for operating X-ray equipment?
Answer — Yes

Question — Why does the direct current machine operate with less efficiency from the standpoint of output than the alternating current machine?
Answer — The output of the direct current machine is limited by the size of the rotary convertor.

Question — What is a rotary convertor?
Answer — It is a device to change direct current to alternating current.

Question — Why is it used?
Answer — A rotary convertor is essential when alternating current is not available because alternating current is necessary in the production of X-rays.

Question — What is the action of the rotary convertor?
Answer — Its speed is momentarily increased then decreased, with a corresponding voltage drop in the convertor.

Question — What is the usual voltage (direct) used in operating the X-ray machine?
Answer — 110 or 220 volts. Preferably 220.

Question — What should be the size of the line wire from the transformer to the X-ray machine?
Answer — 6-8, depending on the size of the unit

Question — If lead wires were too small what would be the result?
Answer — A drop in current and hence the maximum output of the machine would be impossible.

Question — What else governs the size of the lead wire?
Answer — The length of its span.

Question — How would you determine the correct size of the lead wires?
Answer — This information should come from the X-ray manufacturer or perhaps your Power and Light Company.

Question — Which type of current is more commonly used for X-ray work?
Answer — Alternating current.

Question — Why?
Answer — Because there is more alternating than direct current manufactured, and also the peak of AC is higher than DC.

Question — What is the usual voltage supplied the outside transformer or from where you get your source of supply?
Answer — 2200.

Question — What is the use of a pole transformer?
Answer — To step down the high voltage to a value which can be safely used,

Question — Should other power supplies be drawn from the same transformer which supplies the X-ray machine?
Answer — Not advisable.

Question — What would be the result?
Answer — A drop or variation in current.

Question — Is there anything to overcome this?
Answer — Yes, to a certain extent.

Question — What?
Answer — A stabilizer.

Question — How is the machine connected to the outside power line?
Answer — By a main fuse block and switch (safety type).

Question — What size fuse should be used?
Answer — 30 Amperes for small units; 60 Amperes for the larger units.

Question — Where should this switch be placed?
Answer — Near the machine.

Question — Why?
Answer — So the operator standing at his machine can conveniently engage or disengage the main line switch.

Question — What is known as the control board or working panel?
Answer — That part of the machine which suspends the levers, knobs, and dials for the operator's use.

Question — What is the ordinary number of dials and controls on such a panel?
Answer — Modern up-to-date equipment usually has one or two pilot lights for reading meters and a small switch controlling same, a milliampere meter, a kilo-volt-meter, a pre-reading volt meter, an X-ray switch either lever, or button in action, a pre-reading volt button, a filament control button, a bucky release button, in the larger types of machines a polarity indicator, and a main switch when using equipment of the mechanical rectifying type.

A plug is either constructed in the side of the machne or in some cases it is found on the panel to plug in an automatic timer, the foot switch, or Bucky Release cable.

Question — What is the purpose of the main-line wall switch?
Answer — To supply the machine with current.

Question — What is the purpose of the X-ray switch?
Answer — To allow the high tension current to pass thru the tube in the production of X-rays.

Question — What is the purpose of a foot switch?
Answer — To operate the equipment so the operator may use his hands for other purposes such as holding the patient. It is particularly helpful in fluoroscopic work, where it is necessary to hold and move the fluoroscopic screen about.

Question — What type of switch should be used in the machine?
Answer — An oil type to prevent arcing.

Question — What is the purpose of the automatic timer?
Answer — For correctly timing the exposures, particularly when fractional seconds are used. Also, it is then possible to make duplicate exposures.

Question — What is the purpose of the motor switch?
Answer — It is to revolve, start, and stop the synchronous motor or rotary convertor.

Question — What is the synchronous motor?
Answer — One that is always timed with the incoming current.

Question — Why is a synchronous motor used?
Answer — It is the only alternating type motor that can be depended upon to revolve the rectifying switch in such a manner that the switch will always be in a position coinciding wth each alternation of the alternating wave.

Question — What usually is the cause of a synchronous motor being out of time?
Answer — Bearings too tight, in need of oil, or a defective motor; and sometimes frequency above normal.

Question — How is this detected?
Answer — By the polarity indicator swinging from side to side, or a peculiar sound of the switch or the motor.

Question — What is the auto transformer?
Answer — It is a device with numerous voltage steps—used in connection with the auto transformer lever for varying the primary voltage delivered to the high tension transformer.

Question — What voltage is usually delivered from the auto transformer?
Answer — Approximately 35 to 220.

Question — Will the auto transformer act as a stabilizer?
Answer — No.

Question — Do auto transformers have only one control?
Answer — Some have two for finer gradation but the more modern equipment has one to simplify the operation.

Question — Should the auto transformer steps be uniform?
Answer — Yes.

Question — What is a rheostat?
Answer — A device of resistance to absorb some of the power delivered to the step-up transformer.

Question — Is this a part of the modern equipment?
Answer — No. Rheostats with control levers, as a part of the working panel, have become more or less obsolete.

Question — Is the rheostat as efficient as the auto transformer?
Answer — No.

Question — What is a pre-reading volt meter?
Answer — A device to measure the voltage, delivered to the auto transformer before the X-ray switch is engaged.

Question — Why is it used?
Answer — To pre-determine KVP value for duplication.

Question — How does it operate?
Answer — It indicates the voltage of each auto-transformer step or button.

Question — Could a volt meter be used in its place?
Answer — No.

Question — Why?
Answer — Because a volt meter only indicates the main line voltage.

Question — What is a polarity indicator?
Answer — A device to indicate the direction of the flow of the current.

Question — Is such an instrument necessary when using both types of current?
Answer — No. It is not necessary with alternating current units or with self-rectification equipment.

Question — Why isn't it necessary with a self-rectification unit?
Answer — Because the tube itself is self-rectifying—up to a very high degree of heat.

Question — What is a step-up transformer?
Answer — One that transforms a fairly low, primary voltage and a high, primary current to a high secondary voltage and a proportionately lower secondary current.

Question — Are high tension transformers generally oil-immersed?
Answer — Yes.

Question — Why?
Answer — For better insulation.

Question — Should the oil in the step-up high tension transformer be of a certain level?
Answer — Yes, the level to be determined by the manufacturer. Usually the oil should be well over the plates and the core of the transformers.

Question — What is transformer core?
Answer — It is composed of laminated, transformer steel which forms a path for the magnetic line of force, generated by the primary windings.

Question — How many types of cores are there?
Answer — Open and closed.

Question — What is the open type?
Answer — A type which has an open core through its primary and secondary windings.

Question — What is the closed type?
Answer — A type which has an open core through its primary and secondary windings linked by a closed iron core.

Question — What type is ordinarily used in X-ray?
Answer — Closed type.

Question — Why?
Answer — The efficiency of the closed type is greater.

Question — What is a rectifier?
Answer — A mechanical device used to change alternating current into a pulsating direct current.

Question — What types are in use?
Answer — The cross arm and the disc type.

Question — Which is the better type?
Answer — The cross arm.

Questicn — Why?
Answer — It rectifies a greater percentage of the wave.

Question — What is meant by the rectifier being in or out of phase; in other words, out of time?
Answer — It is in phase or in time when it is set to rectify the maximum amount of the wave. Otherwise it is out of time. In this

event there is present usually a long lead spark — sometimes spoken of as the lag spark or the low current values.

Question — What is usually the result of such a spark?
Answer — A loss of energy delivered to the tube and a loss of X-ray output.

Question—What is the milliampere meter?
Answer — An instrument to indicate the amount of current passing through the tube.

Question — What is a stabilizer?
Answer — A device to stabilize or control the milliamperes through the tube.

Question — Will the filament current or Kilo-Volt-Peak variation have any effect on the stabilizer?
Answer — No, within operating limits.

Question — Who invented the stabilizer?
Answer — William Kersley.

Question — Is the stabilizer used for all phases of radiographic work?
Answer — Yes, when operating under 100 milliamperes.

Question — Does the stabilizer have any value if the filament circuit is constant?
Answer — Yes, it eliminates tube testing.

Question — How?
Answer — The stabilizer, once set, will always allow for the same amount of milliamperes.

Question — Will the stalibizer operate on self rectification?
Answer — Yes, but of a different design incorporating the same principles.

Question — Will the stabilizer operate with auto-transformer and rheostat controls?
Answer — Yes.

Question — Will the stabilizer increase the milliampere output?
Answer — No, not above the capacity of the unit.

Question — Will the stabilizer have any effect upon the life of the tube?
Answer — Yes, it should increase the life of the tube because it eliminates tube testing.

Question — What is an overhead system?
Answer — Usually a system of tubular aerial, with proper wiring inside, for the purpose of transforming the current from the machine overhead down to the tube.

Question — Do all X-ray machines employ tubular aerials?
Answer — No. Usually the larger mechanical rectifying units do; the small rectifying units as a rule do not.

Question — Why is tubing used for aerials?
Answer — Because less corrosion forms on the tubing than on the wire itself.

Question — What is the purpose of cord reels?
Answer — To deliver the high tension and filament circuit from the aerial to the tube or from the top of the mast to the tube.

Question — What main line voltage is required to operate the filament circuit?

Answer — Can be 110 or 220 volts; usually 220 volts is stepped down from the main transformer. When only 110 volts is supplied then a small or step down transformer is used.

QUESTIONS AND ANSWERS PERTAINING TO THE DARKROOM

Question — How large a darkroom should be constructed?

Answer — Of sufficient size in which to do your work.

Question — Should it be ventilated?

Answer — Yes.

Question — Why?

Answer — To insure the health of one doing the developing and to assure faster drying of films.

Question — What should be the darkroom equipment?

Answer —

a. suitable developing and fixing tank
b. tank for rinsing (should be placed between the solution tanks)
c. washing tank (supplied with running water)
d. loading bench (should be as far from solution tanks as possible)
e. film cabinet—lead lined (for storing unexposed films)
f. drying rack (more conveniently located over wash tank)
g. rack for suspending developing hangers (more conveniently located over loading bench)
h. shelf over solution tank (necessary for the storage of extra solution in brown bottles)
i. earthen crock or porcelain pail, sufficiently large to mix developer
j. earthen crock or porcelain pail, sufficiently large to mix fixer
k. ebonite container for X-ray hardener
l. two wooden paddles for the mixing of solutions
m. safelight, on shelf over developer
n. illuminator, on shelf over hypo
o. darkroom timer
p. safelight over the loading bench
q. indirect safelight, on ceiling in center of the room
r. bright light over door with switch conveniently located—also switch for indirect safelight
s. spigots, for hot and cold water, if same is available
t. electric fan for quick drying of films
u. gallon glass measure
v. covers for solution tanks
w. solution thermometer
x. trimmer (for trimming films)
y. wastebasket
z. sufficient number of developing hangers (8 x 10, 14 x 17, and 14 x 36 if same is necessary—(also dental clips if dental work is being done).

Question — Should darkroom exclude all ordinary light?

Answer — Yes, also light through keyholes, as well as around doors and windows.

Question — Where should the lights be placed in the darkroom?
Answer — The ordinary light over the door; an indirect safe light on the ceiling in the center of the room, ordinary safelight is above developer and loading bench, illuminator over hypo tank.

Question — Should lights have switches?
Answer — Yes, switches for bright light and indirect ceiling light conveniently located near doorway. Other safelights may be plugged into electric sockets.

Question — Why should the bright light be excluded?
Answer — Such light will fog the unexposed films—those being developed.

Question — How can ordinary light fog be detected?
Answer — By black streaks on the developed film, either around its edges, or across the film. If the entire film was exposed to ordinary light, it would develop a jet black.

Question — Why the illuminator over the hypo tank?
Answer — For the purpose of analyzing wet films.

Question — What color safelight shades may be used?
Answer — Red or green.

Question — Which is the better?
Answer — Matter of opinion.

Question — Are all safelights safe?
Answer — No.

Question — What method is used to determine whether or not they are safe?
Answer — Cut off a small piece of unexposed film under the safe light. Hold a key or a coin in front and against it. Hold same in front of safelight, four to six inches away, for 20-30 seconds. Then develop this film, rinse and fix. If object develops on the film the light is not safe. If it does not develop on the film the light is safe.

Question — How would you make the light safe?
Answer — By putting in a smaller bulb and repeating the test, by using red or green paper in front of the shade, or by placing a piece of unexposed film in back of the shade or colored glass. It is understood that all the safelight possible is an asset to any darkroom, but the light must be safe.

Question — What is the proper wall and ceiling finish for the darkroom?
Answer — Either tan or some other light tone.

Question — What are static marks?
Answer — Abrasions of fine black hair lines on the developed film. These sometimes appear as a fine network of black lines.

Question — What is the cause of these lines?
Answer — Friction, caused by drawing the film's emulsion over an object.

Question — What causes clear or transparent spots on the developed film?
Answer — They may be caused either by kinking or bending the undeveloped film, inferior screens, foreign bodies on the films, or air bubbles in developing.

Question — What causes greasy developed films?
Answer — Insufficient washing and inferior hypo or fixer.

Question — **What causes a reddish stain?**
Answer — Inferior grade of hypo.

Question — **How does overdevelopment appear on the film?**
Answer — A muddy fog.

Question — **How do you know when films are over, under, or correctly exposed when developing?**
Answer — On correctly exposed films the image will begin to appear in approximately one minute and a half, providing of course, that the solution is of the proper strength and temperature.

Question..—..**How would you know when it is of the proper strength?**
Answer — By the number of films developed and the color of the developer.

Question — **What should be the color of proper developer?**
Answer — Clear, very light amber.

Question — **What is the color of worn-out developer?**
Answer — Dark amber, muddy, and riley.

Question — **What should be the proper temperature of the solution?**
Answer — 65° to 68° F.

Question — **How soon will the image of the overexposed film appear in the development?**
Answer — The overexposed film will develop much sooner than one minute and a half.

Question — **What about the development of the underexposed film?**
Answer — The underexposed film is naturally slow in developing and, of course, will not bring the image out 100 per cent.

Question — **How long should films develop?**
Answer — A full six minutes, if correctly exposed. The last minute adds to the detail and contrast of the film.

Question — **How should the correctly exposed and developed film appear when dry?**
Answer — Black and shiny, with contrast and detail. When holding the film below your eyes with the ordinary light striking it at an angle you should be able to detect the black lines which are the outlines of the osseous structure. Film should dry smooth, even and free from dust. Dust will cause the film to dry rough.

Question — **What is the function of the developer?**
Answer — Developing solution oxidizes the silver bromide of the emulsion which has been energized by the exposure.

Question — **What chemicals are ordinarily used in the developer?**
Answer — Usually metol, hydrochinon, sodium sulphite, sodium carbonate, potassium bromide, and always distilled water.

Question — **What is the purpose of each of the chemicals?**
Answer — Metol is an oxidizing agent giving detail and also definition to the film. Hydrochinon is also an oxidizing agent which adds contrast to the film. Sodium sulphite is a preservative while sodium carbonate, an alkali, opens the pores of the emulsion and accelerates the developing. Potassium bromide retards too rapid development. Distilled water acts as a solvent and holds the chemicals together.

Question — **Is it better to weigh and mix your own solution or buy the ingredients in powder or liquid form already mxed?**
Answer — Either of the latter is preferable.

Question — What type of developer should be used?
Answer — Perhaps better results are obtained by using the same brand of developer as are the X-ray films. In other words, if you use a certain brand of film use that brand of developer for that brand of developer is particularly prepared for that type of film.

Question — What should be the temperature of distilled water for mixing?
Answer — 90° to 100° F.

Question — Should new developer be used immediately?
Answer — It can be, but better results are obtained if the solution is allowed to stand for a few hours before using.

Question — Should new developer be added to old in the tank?
Answer — No, but very often this procedure takes place.

Question — Why?
Answer — Because it promotes deterioration.

Question — What is usually the object of adding new to old?
Answer — To fill the solution tank so that the films may be entirely submerged.

Question — What causes the tank solution to lower?
Answer — Usually the removal of films—not allowing the solution to drip back into the tank, plus some amount of film emulsion absorption.

Question — Will extra solution keep?
Answer — Yes, if kept in brown bottles.

Question — What effect will the brown bottle have?
Answer — Keeps the air and light from causing oxidation.

Question — Should the solution be stirred before being used?
Answer — Yes, slightly, to assume even temperature.

Question — How should the films be placed in the developer?
Answer — By quickly submerging and briskly shaking them. Incidentally, it is advisable to unload and place in the hangers the complete set of films if possible, submerging the entire number in the developer at the same time.

Question — What will this prevent?
Answer — An irregular development, also prevents air bubbles from forming on the negative.

Question — What will irregular development cause?
Answer — Possible streaks on the film.

Question — What will air bubbles cause?
Answer — Blisters on the developed film.

Question — What will an oxidized developer produce?
Answer — Slow developing, cause stains, and lessen density and contrast.

Question — What two methods are used in developing?
Answer — Tank and tray methods.

Question — Which one is proper?
Answer — Better results are obtained with the tank method.

Question — What prolongs the life of the developer?
Answer — Keeping the solution covered, maintaining an even temperature, and of course, the amount of films developed.

Question — Can an underexposed film be fully developed?
Answer — No.

Question — Can an underdeveloped but correctly exposed film be further developed?
Answer — Yes.

Question — How?
Answer — By an intensifying solution, but this is not practical.

Question — Can an overexposed film be made readable?
Answer — Yes, by reducing the developing time. This causes a great deal of attention during development to be sure that the film is not too black. One will perhaps have to develop the film in front of a safelight before completing the development. A correctly exposed film may be viewed only once or twice during the six minute developing.

Question — Can an overexposed and an overdeveloped film be made readable?
Answer — Yes.

Question — How?
Answer — By using a reducing solution. But perhaps it would be just as cheap and convenient to take the film over.

Question — How may one determine the six minute period for development?
Answer — By noting the luminous dial of the darkroom timer when development is begun. Then remove the films at the end of six minutes either by re-examining the clock or by using a timer with an alarm.

Question — How does one use the safelight to determine the degree of development of the image on the film?
Answer — Not by holding the film directly in front of the safelight but at an angle, tipping the top of the film slightly away from you, looking between the film and the safelight. When the film is properly developed you will note, using this method, that the outlines show quite sharp and the less denser areas stand out light—to a sort of yellow similar to the ordinary color of the undeveloped emulsion.

Question — What is the proper method of rinsing?
Answer — Use the small rinsing tank of running water between the solution tanks, then briskly swish the film about keeping it completely submerged for about one second.

Question — What will this do?
Answer — Wash off most of the developer left on the face of the film and saves the hypo.

Question — What should be the temperature of the rinse water?
Answer — As near the solution temperature as possible.

Question — What is another name for hypo?
Answer — Fixer.

Question — What is the function of the hypo?
Answer — To dissolve the unexposed and undeveloped silver bromide —leaving a permanent silver oxide image.

Question — How long should films fix or remain in the hypo?
Answer — 15 minutes in a solution of the proper strength and temperature.

Question — Can they be taken out of the solution in front of a bright light within five minutes?
Answer — Yes, even after two or three minutes of fixation but they must be replaced for a total of 15 minutes.

Question — What is the result of an improperly fixed film?
Answer — Stains and also the film will fade.

Question — What are the ordinary chemicals used in the hypo solution?
Answer — Though there are several fixing baths on the market the following ingredients make a good workable solution: sodium hydrosulphite or hypo crystals, sodium sulphite, chrom alum, sulphuric acid, and water.

Question — What is the action of each of these ingredients?
Answer — Hypo crystals act as a solvent for the silver bromide since they dissolve both the unexposed and undeveloped silver bromide particles. Sodium sulphite is a preservative. Chrom alum is a hardener and the sulphuric acid prevents the solution from becoming alkaline in nature, and stops development.

Question — Is it necessary to use distilled water in the hypo solution?
Answer — No.

Question — How long should the hypo solution last?
Answer — It depends upon the temperature and the amount of films fixed.

Question — How would you know when the solution has deteriorated?
Answer — By the delayed manner in which it clears the film and by its color.

Question — What is the color of deteriorated solution?
Answer — A light greenish-blue.

Question — Is it advisable to add new hypo to old?
Answer — Yes, as long as solution hasn't changed its original color.

Question — For what purpose would one add new to old?
Answer — To fill the tank so as to completely submerge the films.

Question — What would be the correct hypo temperature?
Answer — Same as the developer.

Question — What would be the result of cold hypo?
Answer — Retards the fixation.

Question — What should be the temperature of the wash water?
Answer — Not over 70° F.

Question — How long should they wash?
Answer — 30 minutes in proper temperature.

Question — If wash water is too warm what is the procedure?
Answer — There are various hardening solutions to be used, but perhaps one that gets as good results as any, is a hardener of 6 parts water to 1 part of formaldehyde—used between the hypo or fixer and the wash water.

Question — How long should films remain in the hardener?
Answer — Not more than two minutes.

Question — How long should films then wash?
Answer — 30 minutes.

Question — If water is slightly too warm and hardener is not used how long can they wash?
Answer — Not more than 15 minutes and then one should swish them about in the wash water frequently.

Question — What is the result of wash water being too warm?
Answer — Softens the emulsion of the film base.

Question — What is the result?
Answer — A quite porous appearing film — the emulsion sliding or shifting on the base and perhaps completely sliding off.

Question — What is the required time for drying?
Answer — This depends entirely upon the atmospheric conditions. Under ordinary conditions, with the use of a fan circulating the air, a film may be dried, in approximately 1½ hours.

Question — How can films be dried quickly?
Answer — By the use of an electric fan or a solution of grain alcohol.

Question — Which is better?
Answer — An electric fan, as the alcohol sometimes causes the film to dry streaked. However, films should be dried in a warm place—free from dust and dirt.

Question — How do secondary rays affect the film?
Answer — They cause what is known as secondary fog and a dark grayish dirty color appears on the developed film.

Question — How can films be tested for ordinary light, chemical, or secondary fog?
Answer — By developing and fixing any one, or all of the suspected films without the usual X-ray exposure.

Question — How should unexposed films be handled in the darkroom?
Answer — Only by their extreme edges, otherwise finger prints will develop on the film.

Question — Why is it necessary to handle films with perfectly dry hands?
Answer — The edge of film gets sticky and when placed in the cassette between the screens will very often adhere to the screens under pressure.

Question — What make of film is better for radiographic purposes?
Answer — That is a matter of opinion as some films are slightly speedier while others promote more contrast. Any standard make is a good film.

Question — What is a cassette?
Answer — A fixture for keeping the film light proof during exposure.

Question — Should one keep the cassettes always loaded?
Answer — Not for any great length of time. If cassettes are to be kept unloaded then a clean piece of white tissue paper or cardboard should separate the screens.

Question — How should the exposed film be kept?
Answer — Always in a steel filing cabinet; though the standard film of today is not combustible, it is inflammable.

Question — What is the better make of cassettes?
Answer — This is a matter of opinion, any standard make may be used.

Question — How are cassettes faced?
Answer — By aluminum or bakelite.

Question — Which is better?
Answer — Technically, the bakelite offers the least resistance; however, there is so little difference that one would hardly notice it. Incidentally, the price of the two is usually the same.

Question — What is the purpose of the intensifying screens?
Answer — To shorten the exposure and add to the detail of the film.

Question — What is the screen composed of?
Answer — A piece of thin cardboard—usually white, coated with small particles of calcium tungstate.

Question — What is its action?
Answer — These crystals fluoresce, under the influence of X-rays.

Question — Will the tungsten crystals deteriorate?
Answer — No.

Question — How are they used in the emulsion?
Answer — They are suspended by what is called a binder and usually distributed within the emulsion.

Question — Are there various grades of binder?
Answer — Yes.

Question — What grade should be used?
Answer — The very best, as cheap grade will turn a screen yellow.

Question — How is the fluorescence given off this screen governed?
Answer — By the purity of the crystals.

Question — Are the rays given off by the intensifying screens as effective as the X-ray?
Answer — No. They are said to be blue, violet, and of longer wave lengths, so naturally there is less penetration.

Question — How will solution spots affect the intensifying screens?
Answer — If allowed to dry they will produce yellow spots on the screen. If not dry, and the screens contact one another for only a short length of time, the two screens will adhere to one another and, as they are taken apart, the emulsion is very often broken.

Question — Can the wet solution spots be removed?
Answer — Yes, by the use of a tuft of cotton and hydrogen peroxide. The area is slightly rinsed and dried with a tuft of cotton.

Question — Can the dried solution spots be removed?
Answer — No, not without injury to the screen.

Question — Should the screens be removed from the cassette for cleaning?
Answer — No.

Question — How are screens usually cleaned?
Answer — With a tuft of cotton, Ivory soap, and lukewarm water, thoroughly rinse the soap from the screens, using a tuft of cotton for drying and then place screens in the sun for further drying. The sun also tends to bleach the screens.

Question — How are the screens adhered to the cassette?
Answer — By a small amount of adhesium at the extreme corners.

Question — How is the cassette made light proof?
Answer — By employing a piece of felt, slightly larger than the cassette cover itself. When the cassette cover is closed the felt forces its way between the cover and the frame of the cassette making it light proof. It is sometimes necessary to replace this felt to prevent ordinary light from reaching the film.

Question — How does one know whether the cassette is leaking light?
Answer — By the black streak around the border of the developed film.

Question — What are dead spots?
Answer — Areas on the film which lack the same amount of detail and contrast.

Question — How are they produced?
Answer — Either by a poor contact of film and screen, or by a shifting, causing a density of tungsten crystals.

Question — How does this happen?
Answer — First, too much adhesium raising the corners of the screens or by a lack of elasticity of binder causing the crystals to move out.

Question — What causes light specks on the developed film?
Answer — Usually dirt or foreign bodies — collecting on the screen surface.

Question — How could one prevent it?
Answer — By brushing out the cassette with a camel hair brush.

Question — Are all screens the same speed?
Answer — No.

Question — Why?
Answer — Because they are manufactured in slow, medium, fast, and extra fast.

Question — Which is the better for radiographic purposes?
Answer — Though the fast is more generally used, perhaps the medium will give the best definition but an extension of exposure time is necessary. This is not generally used because of the possibility of motion.

Question — What is meant by screen speed?
Answer — This is the relative amount of X-ray exposure required, between the use of a film with intensifying screens and without. If a given technic requires one second to obtain a radiograph, with intensifying screens, and five seconds exposure when screens are not used—then the ratio is 5 to 1.

Question — How can the speed of a screen be increased?
Answer — By increasing the size of the tungsten crystals up to a certain point.

Question — How can a pair of screens be tested for speed?
Answer — Make a correct exposure, using one second of time with corresponding machine technicalities. Develop the film in the usual manner. Then make several exposures of films without the screens until a like density is obtained. Count the number of exposures without screens and you will have the ratio to one.

Question — What is meant by double screen technic?
Answer — Employing the use of two screens.

Question — How is the film used with screens?
Answer — The film is placed between the two screens.

Question — Why are two screens used?
Answer — Because films are coated on both sides of the base, thus permitting the two screens to work on both sides of the coating.

Question — **What are the important points to be considered in a screen?**
Answer — Speed, grain, lag, uniformity, contrast, and cleanability.

Question — **What causes screen grain?**
Answer — Usually the tungsten crystals are too large.

Question — **What promotes uniformity?**
Answer — The general distribution of tungsten crystals.

Question — **What is lag?**
Answer — Lag is an afterglow of the fluorescence. In other words, the screens continue to fluoresce after the X-ray exposure has ceased.

Question — **What causes lag?**
Answer — An inferior grade of calcium tungstate.

Question — **How would one test for lag?**
Answer — Expose an unloaded cassette but with screens with a coin or a key as the object. Remove cassette to the darkroom and load with film. Leave the film in contact with the screens for five minutes. Then remove the film, develop in the usual manner and if an afterglow is present or the screens are laggy, the object will reveal an outline on the film.

Question — **Is this lag detrimental?**
Answer — Yes.

Question — **Why?**
Answer — It may give the film a double exposure appearance.

Question — **What is the result of poor film and screen contact?**
Answer — A lack of definition and a haziness, or fuzziness of outlines.

Question — **What is meant by a cleanable screen?**
Answer — A screen that may be washed removing the dust particles without injury to the screen.

Question — **Are all screens cleanable?**
Answer — No.

Question — **What is the base of the X-ray film?**
Answer — Cellulose acetate.

Question — **Should the same size films and screens be used together?**
Answer — Yes.

Question — **Why?**
Answer — If a film smaller than the screen is used there is a possibility of scratching the screen when attempting to remove the film.

Question — **Should cassettes be loaded in the dark?**
Answer — Yes, absolutely.

Question — **What are the ingredients of the binder?**
Answer — A gelatin process whose ingredients are secretly known.

Question — **Are single screens used?**
Answer — Generally no. The modern and up-to-date method is the double screen.

Question — **Will developing hangers wear out?**
Answer — Yes.

Question — **Why?**
Answer — The solution forms a corrosion on the hangers which takes out the temper of the clip springs.

Question—Can this be overcome?
Answer — Yes, to a certain extent, by occasionally soaking the hangers in acetic acid, then washing them.

QUESTIONS AND ANSWERS PERTAINING TO THE BUCKY DIAPHRAGM

Question — What is a Bucky Diaphragm?
Answer — A device, with movable grid, used in radiographic work to eliminate the greater percentage of secondary and angling rays.

Question — What is the result of secondary radiation on the film?
Answer — It fogs the film.

Question — Who developed the Bucky diaphragm?
Answer — Drs. Potter and Bucky.

Question — What types of Buckys are manufactured?
Answer — Flat and curved types.

Question — Which is the better?
Answer — The flat is more universally accepted.

Question — In what sizes are they made?
Answer — At least three sizes: 8 x 10, 14 x 17, 14 x 36, also larger.

Question — Will the Bucky work horizontally or vertically?
Answer — The modern ones will work either way.

Question — What is the percentage of such radiation eliminated?
Answer — It is said to be from 75 to 90 per cent.

Question — For what class of work is the Bucky diaphragm used?
Answer — Practically all types of radiographic work, except for the extremities and the chest.

Question — What are the working parts of the Bucky diaphragm?
Answer — Movable grid, consisting of strips of lead and wood; a plunger and cylinder or motor for the purpose of making the grid travel synchronously with the exposure time; a lever for drawing the grid to one side; a release, either to be worked manually or electrically, to start grid in motion; a tray for supporting cassettes; a timing device, for regulating the travel of the grid; an electric bell, to note the starting or stopping of grid or both; a supporting frame; a tipping or angling device, an aluminum or bakelite top; proper springs, and an immobilizing device.

Question — Will the Bucky operate with instantaneous technic?
Answer — No.

Question — Why?
Answer — Because with instantaneous technic grid lines will appear on the film.

Question — What is the minimum amount of time to be used with the Bucky?
Answer — Approximately one second.

Question — What causes grid lines to appear on the film?
Answer — Shortening an exposure, a grid not in motion, one not traveling in synchronism, vibration, not in position, or not in proper location with tube or rays that are being driven diagonally toward the Bucky.

Question — Is the Bucky diaphragm a necessity?
Answer — Yes.

Question — Why?
Answer — It eliminates fog and brings out the lines of demarcation.

Question — Why are lead and wood strips used in a grid?
Answer — Lead is opaque and will absorb the secondary and angling rays which strike it.

Question — What is the purpose of the wood?
Answer — It allows the more direct rays to penetrate.

Question — Of what thickness are the lead and wood strips?
Answer — The wood strips are approximately 1/16" thick and the length of the grid. The lead strips are 1/5" to 1/800" thick and the length of the grid.

Question — How are they mounted in the grid?
Answer — First a strip of wood and then a strip of lead, then when the grid is traveling with its center directly beneath the object, the direct rays are practically unobstructed by the lead, the angling rays striking the lead either towards the top or the bottom of the lead.

Question — What does grid ratio mean?
Answer — It means the difference between the thickness of the lead and the wood.

Question — What is the usual ratio?
Answer — Approximately 6 to 1.

Question — Why are lead strips so thin?
Answer — To permit more energy to reach the film.

Question — Will any type of wood do in making the wood strips?
Answer — No, only certain kinds which have no pitch.

Question — What is the depth of the grid?
Answer — Approximately ½".

Question — Why is it necessary that the depth of the grid be as small as possible?
Answer — The shorter the distance between the patient and the film, the less the distortion, and the better the detail.

Question — Why are grids various sizes?
Answer — To cover various size films.

Question — Why should the grid be approximately 3" wider than the film?
Answer — Because the grid travels approximately 3" and it is necessary that the entire film area be completely covered during the exposure.

Question — What was the first type grid made?
Answer — Curved.

Question — Why was a flat grid then made?
Answer — To lessen the size of the Bucky and make it possible for the object to be near the film.

Question — What types of cylinders are used?
Answer — Oil and air, operated by either springs or electric motor.

Question — Which is the better cylinder?
Answer — Oil.

Question — How is it constructed?
Answer — A certain size cylinder and piston is used making two complete chambers in the piston. The head of the piston has a certain number of various size holes or a slotted hole the size of several various size holes or perhaps more commonly called a vent. Then a plate fits tightly in front of the piston head which is so con-

structed that by turning the Bucky timer button these holes or slots or vent open and close allowing more oil or air to get through them regulating the time of complete travel of piston or the time of complete travel of grid. In other words the oil moving from one chamber to the other would naturally change the speed of the piston or plunger.

Question — Is it possible to find air bubbles in the oil chamber?
Answer — Yes.

Question — What is the result?
Answer — A jerking or irregular travel of grid which may result in grid lines appearing on the film.

Question — Can this condition be remedied?
Answer — Yes.

Question — How?
Answer — By pulling out the plunger rod and releasing it several times.

Question — What would be the result if the grid did not begin its travel before the exposure and yet continued to travel after the exposure?
Answer — Grid lines on the film.

Question — What is the purpose of the cassette carrier?
Answer — To support the cassette in the Bucky diaphragm.

Question — What is the purpose of the aluminum or bakelite top?
Answer — To support the patient and to cause less resistance to the X-rays.

Question — What is the function of the immobilization device?
Answer — To hold the patient still during exposures.

Question — What does such a device consist of?
Answer — A light canvas band or rods with rubber ends.

Question — Does the Bucky diaphragm require more time?
Answer — The flat type Bucky may require a very little more time or an increased voltage. The curved types require a little more time.

Question — What is the maximum tube distance to be used with the Bucky diaphragm?
Answer — With the flat type good results are obtained with as much as 60″ and even more tube distance. If the grid is curved to the arc of a circle—50″ in diameter, the tube distance will be the radius or 25″. For instance, the complete circle of the arc has a diameter of 60″, then the tube distance will be half the diameter, the radius or 30″.

Question — Can stereoscopic procedure be carried out with a Bucky diaphragm?
Answer — Yes, always, when the tube is shifted horizontally, and up to a certain point vertically. Otherwise Bucky grids would necessitate running the strips in the opposite direction.

Question — Can the tube be tilted towards the center of the Bucky in the tube shift?
Answer — Yes, up to a certain point, then a proportionate change in tube shift and tube distance must be made.

Question — Is it advisable to use intensifying screens with the Bucky?
Answer — Yes.

Question — Why?
Answer — Because the required exposure time without screens would be greater. All factors being equal the time of exposure of screens with Bucky is reduced as much as one-fifth. This in turn not only aids in eliminatng motion but adds to the safety of the patient.

Question — What tube should be used with the Bucky?
Answer — In radiographic work as fine a focus tube as possible.

Question — Does the grid have to be released manually?
Answer — No, an automatic release can be installed in the machine. This means that you cock the grid or draw it back in position for operation and then by pressing the bucky release button on the machine (which all up-to-date equipment has), the high tension current goes on and at the proper time the grid is automatically released by a magnetic release.

Question — How long should the grid travel before and after exposure?
Answer — Approximately two seconds.

Question — Should the Bucky always operate either vertically or horizontally?
Answer — No.

Question — Why?
Answer — With patient in upright position, the Bucky should be angled to correspond to the general angle of the region exposed with the tube nearly always on the same parallel plane with Bucky. With the patient in the supine position, the Bucky is always horizontally level.

Question — Should there be any graduation on the face of the Bucky?
Answer — Yes. There should be two plane lines, at right angles to the center of the Bucky. When using the Bucky in a position for upright work it is advisable to mark off the size of the film, particularly in 8 x 10 work. If the bakelite face is used such grooves may be filled with white paint which does not have a great deal of white lead. This has an advantage in centering the patient in front of the film.

QUESTIONS AND ANSWERS PERTAINING TO CALIBRATION IN TECHNICAL PROCEDURES

Question — What is the principal factor responsible for failure to duplicate results?
Answer — Usually the voltage factor.

Question — Why?
Answer — Because of incorrect measurements of voltage.

Question — How would you calibrate?
Answer — Make a complete chart of the machine technicalities, having used a sphere gap to test the control's action for accuracy.

Question — Will the same pre-reading voltage give the same amount of KVP for all MA?
Answer — No. As the MA is increased or decreased, a respectively higher or lower voltage will be necessary to give the same KVP.

Question — Is it possible to successfully calibrate a self-rectifying unit?
Answer — No.

Question — How long does it take to calibrate the ordinary X-ray unit?
Answer — The average time is from two to three hours.
Question — Is calibration injurious to the machine or tube?
Answer — No, not if properly done.

QUESTIONS AND ANSWERS PERTAINING TO THE SPHERE GAP

Question — What is a sphere gap?
Answer — An instrument for measuring high tension alternating current.
Question — How is it used?
Answer — It is connected with the X-ray unit. It measures the volume across the terminals of the X-ray tube.
Question — Can the results of a given spark gap be duplicated on another machine, all factors being equal?
Answer — Yes.
Question — What term is used to designate measure with a sphere gap?
Answer — Kilo-volt-peak.
Question — Of what material are sphere gaps made?
Answer — Brass and copper.
Question — What are the important parts of the sphere gap?
Answer — Spheres of proper size, properly spaced with proper insulation; correct scale; and a lever or cord which enables one to gradually and steadily draw one sphere towards the other.
Question — To what circuit should the sphere gap be connected?
Answer — The tube circuit and as near to the tube as possible.
Question — Will an electric fan affect the sphere gap?
Answer — Yes.
Question — In making the sphere gap test, is it necessary to make more than one reading?
Answer — Yes, make three and divide the total by three. This is the average. A slight variation in voltage, or failing to stop the spheres at the exact point of break-over, may cause slight differences in reading.
Question — Should each and every machine for radiographic purposes be tested for sphere gap?
Answer — Yes, to make correct calibration. On shockproof equipment of modern manufacture this is done at the factory.

QUESTIONS AND ANSWERS PERTAINING TO THE STEREOSCOPE

Question — What is a Stereoscope as applied to radiographic work?
Answer — An instrument constructed to give the interpreter a depth perspective of the region under observation.
Question — What is its purpose?
Answer — To give the third dimension.
Question — For what type of work is it generally used?
Answer — Spine, chest, pelvis, and head.

Question — **Of what does the Stereoscope consist?**
Answer — A center assembly with rotating mirrors (mirrors will function back and forth and tip laterally), usually two illuminators properly placed on either side of the mirrors (distance between illuminators and mirrors may be increased or decreased by lever action), illuminators may be made to rotate towards the interpreter, one or more electric bulbs in each illuminator, opal blue glass in each illuminator, rheostat for fusing light, some constructed to operate on table or desk, others to hang on the wall, while some are made to operate on a movable stand.

Question — **Why change the distance between the illuminators?**
Answer — To be able to visualize from a slight angle.

Question — **What is the usual position of the illuminators as compared to the mirrors?**
Answer — Right angles.

Question — **Why tilt the mirrors laterally?**
Answer — To horizontally level certain descriptive parts in order to fuse the films.

Question — **Why the up and down adjustment of mirrors?**
Answer — To make reading more convenient for the interpreter as well as to aid in fusing the films. The vertical center of the mirrors should be in line with the center of the area examined.

Question — **What voltage is necessary to illuminate the stereoscope?**
Answer — Ordinary house electric circuit. This ranges from approximately 104 to 110 volts.

Question — **Why is it necessary that the mirrors move backward and forward?**
Answer — To compensate for a slight error in film distance.

Question — **How many films are necessary in a stereoscopic set?**
Answer — Two.

Question — **Why are two films necessary in stereoscopic work?**
Answer — Because each film must receive a different focus of direct rays. That is to say, during the exposure of the first film the tube is shifted right of the median line and then shifted the same distance left of the median line when exposing the second film.

Question — **What is meant by tube shift?**
Answer — One-half of the tube separation. In other words, if the tube separation is 3 inches at 36 inch tube distance, the tube shift is 1½ inches each way of the median line.

Question — **What is tube separation?**
Answer — The total amount of tube shift.

Question — **How is tube separation determined?**
Answer — By the approximate distance between the pupils of the normal eye.

Question — **What are the various sized stereoscopes?**
Answer — 8 x 10, 8 x 36, 14 x 17, and 14 x 36.

Question — **Is the rheostat attachment necessary?**
Answer — Yes.

Question — **Why?**
Answer — It fuses the light so that the entire area will assume a more equal density.

Question — Will flat or natural pictures reveal as much information as the stereoscopic views?

Answer — Absolutely no.

Question — Why?

Answer — In flat pictures structures appear as a mass piled in front of one another. Stereoscopic views reveal depth so that objects may be seen far and near from the film. This is third dimension. Further anomalies and malformations in stereoscopic work may be seen from a different angle.

Question — Is there anything that may be added to the stereoscope for better visualization?

Answer — Yes, two adjustable magnifying glasses with graduated stems or handles. The glasses operate between the illuminators and mirrors, one on either side of the mirrors.

Question — Of what value are the magnifying glasses?

Answer — They magnify the image which tends to add to the depth of the films.

Question — How are they focused?

Answer — Center of the magnifying glasses should be in line with the center of the object to be interpreted. Please note the position of these glasses as this is very important.

Question — How is the stereoscope operated?

Answer — When visualization is being made, the interpreter should place his eyes as near to the mirrors as possible, certain position of stereoscopic blinds will eliminate unnecessary light and perhaps foreign shadows appearing in the mirrors. Turn on the light. See that illuminator face is at right angles with the base, slide rods, or frame, or center of mirrors. If using the type of stereoscope illustrated in this text, force the assembly away from you within one half inch of its back bracket. See that the opal glass is free from dust. Properly insert the films. Ordinarily the right film goes in the left box with the marker to you. The left film goes in the right box with the marker away from you.

With PA Vertex stereos the right film goes in the right box with the marker to you and the left film goes in the left box with the marker away from you. The reading is made from the anterior. What is the operator's left is in reality the patient's right side and vice versa. To read such views from the posterior, the right film is placed in the right box with the marker away from you and the left film is placed in the left box with the marker to you. Readings are then made according to the interpreter's right side. That which is the operator's right is actually the patient's right side.

AP Vertex stereos are read the same as AP and Diagonal stereos.

Question — How are they fused?

Answer — Locate some prominent and similar points of structure on both films.

Question — What points are preferable?

Answer — In cervical work, the occipital protuberance, the odontoid of Axis, lateral masses, spinous of Axis. Of other osseous regions, the spinous processes, pedicles, mammillary processes, or outlines of bodies or extremities are located.

Question — How are they leveled?
Answer — Having located prominent and similar points, rotate the mirrors until both points are exactly horizontally level. Without changing the lateral tipping of the mirrors carefully rotate them until the two similar points or the images unite fusing as one. Gradually move the entire center assembly forward and then backward until they re-fuse, being very careful not to change the degree of rotation of mirrors or lateral tipping of same. Then manipulate the rheostat until the proper density of light is obtained.

Question — What is the ratio of tube separation to tube distance?
Answer — Approximately one inch separation to one foot of tube distance.

Question — Can the tube be shifted vertically as well as horizontally?
Answer — Yes, when not using Bucky diaphragm unless grids may be had with strips running horizontally for the vertical shift and vertically for the horizontal shift.

Question — What is the vertical shift used for?
Answer — Chest work, generally.

Question — What is the horizontal shift used for?
Answer — Spine, pelvis, head, etc.

QUESTIONS AND ANSWERS PERTAINING TO THE FLUOROSCOPE

Question — What is the fluoroscope?
Answer — A device with which fluoroscopic and visceral examinations are made.

Question — What is its general purpose?
Answer — For the examination of the movable parts of anatomy, to locate foreign bodies, and use in setting fractures.

Question — Of what type are they made?
Answer — Either vertical or horizontal or a combination of both. They are called the standard and hand type.

Question — How are they operated?
Answer — The standard is operated in a totally dark room. The hand type may be operated in a light room because it is so made to fit the contour of the front part of the head, excluding all ordinary light between the screen and the eyes of the one making the examinations.

Question — What are the positions ordinarily used in fluoroscopic work?
Answer — Vertical, horizontal, and angular.

Question — What is meant by the angular position?
Answer — When the patient is placed in any position other than the horizontal or vertical position.

Question — What is fluoroscopy?
Answer — Refers to the method in making such X-ray examination with the fluoroscope.

Question — Describe the fluoroscope.
Answer — It consists of a framework supporting an X-ray tube. The tube is enclosed in a light proof lead glass container. A fluoro-

scopic screen is mounted in the frame beneath a lead glass plate. (Lead glass should contain the equivalent of 1/16 inch of sheet lead.) The tube and screen should move up and down synchronously. The framework between the tube and screen consists of special type of perfectly seasoned wood or bakelite—bakelite preferable, and thickness approximately 5/16 of an inch. Between the tube and the partition are two pairs of shutters, directly in front of the tube. They are made to open and close by mechanism on either side of the frame so examiner can conveniently operate during the examination. The shutters increase or decrease the field being visualized. The smaller the field area made by the shutters the sharper the image and the finer the detail. This is done by the closing of the shutters from the top down and the bottom up and from side to side.

Question — Will ordinary plate glass do to cover the screen?
Answer — No.

Question — Why?
Answer — Ordinary plate glass will not offer sufficient resistance to the rays making such a procedure very hazardous to the operator.

Question — Should the hand fluoroscope screen be covered with glass?
Answer — Yes, absolutely.

Question — Why?
Answer — For the same reason as that of the large fluoroscopic screen —to protect the operator.

Question — What other methods are used for protecting the operator in fluoroscopic work.
Answer — Lead rubber apron, lead rubber gauntlets, leaded goggles, and leaded skull cap.

Question — What is meant by a laggy fluoroscopic screen?
Answer — One having a tendency to retain its fluorescent action after the production of X-rays cease.

Question — What effect will a laggy screen have?
Answer — It materially interferes with contrast and detail.

Question — Do fluoroscopic screens deteriorate from ordinary usage?
Answer — Very little if any.

Question — Will fluoroscopic screens deteriorate with age?
Answer — Yes, but very slowly.

Question — What causes fluoroscopic screen deterioration?
Answer — An inferior binder used in the screen's emulsion for the purpose of suspending the screen's crystals.

Question — Can the fluoroscopic screen be used with any type of unit?
Answer — Yes, so far as transformer and tube are concerned.

Question — Can a grid be used in connection with the fluoroscopic screen?
Answer — Yes, one similar to one used in radiographic work.

Question — For what is its purpose?
Answer — To eliminate secondary radiation.

Question — Will grid lines appear when making the examination?
Answer — Yes.

Question — How is it used?
Answer — Between the screen and the patient.

Question — What is the better tube to use in fluoroscopic work?
Answer—A medium fine focal line tube.

Question — What is meant by a medium fine focal line tube?
Answer — One having a fine focus rather than a focal point.

Question — What is the width of the medium fine focus line?
Answer — Approximately 5/64 inch.

Question — What capacity tube is generally used?
Answer — 5-30.

Question — What is the maximum voltage and milliamperes used within the safety limit?
Answer — 88 KVP or a 5 inch spark gap and 3 to 5 milliamperes.

Question — Why is a finer focus tube used?
Answer — To sharpen the fluoroscopic image.

Question — Why is a lesser amount of milliamperes used?
Answer — To lessen the danger to the patient and the tube.

Question — What is the procedure of the operator just before making the examination?
Answer — The operator should remain in the fluoroscopic examination room approximately fifteen minutes before making the examination.

Question — Why?
Answer — As this room is perfectly dark he must remain this period of time so that his eyes will become accustomed to the darkened room.

Question — How should the fluoroscopic exposure be made?
Answer — Intermittently.

Question — Why?
Answer — It aids in prolonging the life of the tube.

Question — Why should the tube be completely covered and insulated?
Answer — To exclude all filament light and protect the operator.

Question — Is there any danger of giving the patient too much fluoroscopic exposure?
Answer — Yes, absolutely.

Question — What is the maximum time of exposure to be used in fluoroscopic examinations?
Answer — Never more than fifteen or twenty minutes at a 15 inch target skin distance using a 1mm. aluminum filter between the tube and the shutters.

Question — How soon can the examination be repeated?
Answer — Not advisable under thirty days.

Question — What other precautions are used for the safety of the patient?
Answer — Have fluoroscope grounded, unit well insulated and all high tension wires out of reach.

QUESTIONS AND ANSWERS PERTAINING TO X-RAY TUBES

Question — Who invented the radiator type of tube?
Answer — Dr. W. D. Coolidge of the General Electric Company and it was so named in his honor.

Question — How are they classified?
Answer — Air-cooled deep therapy and water-cooled deep therapy, universal radiator type for general use, portable use, and the right angled dental type.

Question — Name two makes of radiator type tubes.
Answer — Coolidge and Eureka.

Question — How may these be classified?
Answer — Fine focus, medium fine, medium, and so called broad.

Question — What sort focal point has the Eureka?
Answer — Line.

Question — What is the width of this focal line?
Answer — 3/64 inch or 3-100, 5/64 inch or 5-100, 9/64 inch or 9-100, and 12/64 inch or 12-100.

Question — Which one is generally used in radiographic work?
Answer — The 5-100 or 9-100 although the 3-100 may be used in extremity work.

Question — When was the Eureka tube placed on the market?
Answer — About the year 1919.

Question — Are there any other types of tubes?
Answer — Universal and many others.

Question — What types of Universal tubes are on the market?
Answer — Fine, medium, and broad focus.

Question — When was the Coolidge tube first placed on the market?
Answer — 1912.

Question — What sort of cathode has these two tubes—Coolidge and Eureka?
Answer — Hot cathode.

Question — Do the Eureka people make another type tube?
Answer — Yes, the oil immersed and the ray proof shield tube, also the right angled dental tube.

Question — What does the hot cathode tube consist of?
Answer — A thin shelled glass bowl with two arms extending in opposite directions. From the center to one end of the tube is the copper anode with its connection to that end of the tube. The other end is known as the cathode with its filament and reflector parts. The anode end is supplied with one wire connection while the cathode end is supplied with two wire connection.

Question —Which end receives the low voltage?
Answer — The cathode.

Question — What is the usual low voltage?
Answer — 6 to 12 volts.

Question — For what is its purpose?
Answer — To heat the filament wire.

Question — Why heat the filament wires?
Answer — To produce electrons.

Question — Why produce electrons?
Answer — To conduct the current from the anode to the cathode.

Question — What happens then at the cathode end?
Answer — The current is whipped back into a stream by the reflector against the anode end.

Question — What is this stream called?
Answer — Cathode stream, or electron stream.

Question — What is the velocity of the cathode stream?
Answer — It depends upon the force of the voltage.

Question — Does the target absorb this stream?
Answer — No.

Question — How are X-rays produced?
Answer — By the bombardment of the cathode stream against the target.

Question — What part of the target receives this bombardment?
Answer — The focal point or line.

Question — What is this point made of?
Answer — Tungsten material.

Question — Why?
Answer — It is sufficiently hard to stand the impact.

Question — How is it constructed?
Answer — Usually round, the size of an ordinary button and pinned flush into the copper anode.

Question — How is the copper anode or flush cut?
Answer — At approximately an angle of 22 degrees.

Question — How is it finished?
Answer — Ground flush.

Question — How are these ends assembled into the glass bowl?
Answer — Glass bowl is made into two halves, each end completely assembled and then fused together by artificial heat with parts revolving in a certain type lathe.

Question — How are these tubes made of high vacuum?
Answer — By sealing them in an electrical furnace putting through a continual heavy charge of current for a number of hours.

Question — What does this do?
Answer — Heats the anode end or copper to a white heat.

Question — What is the next step?
Answer — Allow the tube to gradually cool.

Question — What effect does this have on the tube?
Answer — Eliminates the gas resulting in a high vacuum instrument.

Question — What is the life of an X-ray tube?
Answer — Indefinite.

Question — Are they guaranteed?
Answer — No.

Question — What is the usual cause of the tube becoming gassy?
Answer — Too heavy a charge or too many consecutive exposures.

Question — What is another cause?
Answer — The tube becoming punctured or the copper anode cracking allowing the tungsten button to become loose.

Question — What is the purpose of the radiator?
Answer — To disperse the heat.

Question — What is another name for a hot cathode tube?
Answer — Self-rectifying tube.

Question — How does this tube rectify its current?
Answer — By keeping its heat below a certain point.

Question — What other means of rectification are there?
Answer — Mechanical rectification, and valve tube rectification.

Question — How is this made?
Answer — By revolving the mechanical rectifier, and by use of valve tubes.

Question — How many types of mechanical rectifiers are there?
Answer — Two, the disc and metal cross-arm.

Question — What is another name for a self-rectifying unit?
Answer — Motorless type.

Question — What is the usual capacity or amperage?
Answer — Ordinarily, 30-60 although a slight increase in milliamperes may be had by decreasing the voltage or KVP.

Question — What is the capacity of the motorless type?
Answer — Five inch back up, approximately 90 KVP or 90,000 volts. Anything greater than this in capacity is the motor unit or the mechanical rectifying unit.

Question — Why is the focal point line narrow?
Answer — Because it makes sharper outlines adding detail to the pictures.

Question — What type of tube is ordinarily used with the non shock-proof equipment?
Answer — Ordinarily radiator type in radiographic work.

Question — What is meant by shock-proof tube?
Answer — Tube usually immersed in oil with its wire end absolutely insulated.

Question — Why are hot cathode tubes popular?
Answer — The electronic emission and the high potential may be easily and quite accurately determined.

Question — How?
Answer — By regulating the cathode filament.

Question — What is another name for the anode end of the tube?
Answer — Positive or plus.

Question — What is another name for the cathode end of the tube?
Answer — Negative or minus.

Question — How does gas appear in the tube?
Answer — It is often visible as a hue of greenish fluorescence, and also noted as a variance in the milliamperes.

Question — Can a small amount of gas in the tube be eliminated in your laboratory?
Answer — Sometimes putting through a charge intermittently will eliminate the gas, otherwise the tube must be returned to the factory for repairs.

Question — What does the discoloration of the tube signify?
Answer — A chemical change within the tube during the production of X-rays or a deposit of tungsten on the inner wall of the tube.

Question — How is this caused?
Answer — By a too high potential or use of the tube beyond its rate of capacity.

Question — Will such discoloration interfere with the quality of work?
Answer — Not materially, but rather shorten the life of the tube.

Question — How are tubes shipped from the manufacturers?
Answer — In crates with tubes suspended by springs and canvas strips.

Question — What is another name for a cold cathode tube?
Answer — A gas tube.

Question — What is the better for radiographic work?
Answer — The hot cathode.

Question — Is the quality of work produced the same by using either hot or cold cathodes?
Answer — Yes, approximately. Operating the hot cathode work may be speeded up.

Question — What is meant by direct radiation from the tube?
Answer — The radiation emanates from the focal spot or line.

Question — What is secondary radiation?
Answer — That radiation produced when X-rays meet with resistance and are not absorbed.

Question — What type of metal is better used for absorbing secondary radiation?
Answer — Lead.

Question — Of what thickness must the lead be to absorb the ordinary amount of secondary radiation?
Answer — It should be equivalent to 1/16 inch of virgin sheet lead.

Question — What is meant by virgin sheet lead?
Answer — Chemically pure lead.

Question — What is meant by stray radiation?
Answer — That radiation which is directed from parts of the tube other than the focal spot or line.

Question — What is meant by soft rays?
Answer — X-rays having little penetrative value.

Question — What are hard rays?
Answer — Hard rays are those of short wave length, the result of high potential.

Question — Are X-rays the same as ordinary light rays?
Answer — No, light rays are much longer than X-rays, therefore weaker.

Question — How is the heat from a hot universal anode dissipated?
Answer — Through the wall of the glass tube itself.

Question — Why is copper used in making the anode end?
Answer — Because copper permits rapid removal of heat from the anode.

Question — How is the focal width determined?
Answer — First drill approximately a 3/64 inch hole through a piece of sheet lead. Place the lead sheet halfway between the focal line of the tube and the X-ray film. Make ordinary exposure and the width of the black line on the film will be equivalent to that line or spot in the tube target.

Question — Does pitting the target of this tube enlarge the focal spot?
Answer — No.

Question — Can a storage battery be used to light the filament?
Answer — Yes, but not advisable.

Question — How are the milliamperes registered?
Answer — By an ammeter.

Question — How is the voltage registered?
Answer — Through the tube by a volt meter.

QUESTIONS AND ANSWERS ON ROTATING ANODE TUBE

Question — What is the most recent achievement in present day tube manufacture?
Answer — The perfection of the rotating anode tube.

Question — What principle is employed in its manufacture?
Answer — The principle of placing a tungsten disc on a rotor.

Question — What is the purpose of the rotor?
Answer — To revolve the tungsten disc.

Question — What advantages are obtained by using a rotating anode?
Answer — Greater tube capacities and a smaller effective focal spot.

Question — How many revolutions per minute does the anode usually revolve?
Answer — Usually from 3000 to 3600 revolutions per minute.

Question — Does the rotating anode tube have more than one focal spot?
Answer — Yes.

Question — What are the sizes usually?
Answer — The small focal spot is usually 1mm. while the large focal spot is usually 2mm.

Question — Is there any particular angle of bevel of the focal spot area?
Answer — Yes, usually 15 degrees.

Question — How are these tubes cooled?
Answer — By air and oil.

QUESTIONS AND ANSWERS PERTAINING TO THE OPERATION OF THE MACHINE

Question — What are the principal factors in technic?
Answer — Distance, exposure, milliamperes, and penetration.

DISTANCE

Question — What does distance refer to?
Answer — In radiographic work, it refers to the distance from the tube target or focal point to the film. This is known as tube distance. Though skin distance does not refer to radiographic work, it means the distance from the tube target or focal point to the skin of the individual. This is used in X-ray therapy.

Question — How is distance measured?
Answer — Usually in inches.

Question — What is another name for tube distance in radiographic work?

Answer — Focal film distance.

Question — What is the standard tube distance?

Answer — That varies with areas or regions to be exposed and by the procedure of certain X-ray technicians. However, distances range from approximately 18 to 72 inches. Dental work usually averages 18 to 20 inches, extremity work 25 to 36 inches, spine work 30 to 60 inches, and chest work 72 inches.

Question — Will the various machines have anything to do with tube distance?

Answer — Greater distance may be used with machines having a greater capacity.

Question — What is the minimum skin distance?

Answer — 15 inches. To increase this to 18 inches increases the safety measure and eliminates the danger to the patient. To decrease the tube distance adds danger to the exposure. Altering the tube distance plays a very important part with the patient.

Question — Will the tube play an important part in the distance factor?

Answer — Yes. Larger focal point tubes can be used for greater distances. Smaller focal for shorter distances. The larger the focal point, the less the detail. The finer the focal point the sharper the detail.

Question — What effect does tube distance have on the film?

Answer — Increased tube distance to a certain point should produce less distortion and detail should be quite satisfactory.

Question — Will changing the tube distance affect radiographic density, all other factors remaining the same?

Answer — Yes. The radiographic density will vary inversely as the square of the distance. Multiplying the distance by two gives one-fourth the density. Dividing it by two, results in four times the density.

Question — Is it wise to alter the tube distance?

Answer — No, not when once fixed.

Question — What distance should be used with the Bucky diaphragm?

Answer — That depends on the ratio of the grid. In other words, how many lead strips to wood strips per inch. This information should come from the manufacturer of the Bucky diaphragm. Perhaps the best results are obtained at 36 inches with the Bucky diaphragm.

Question — What is the objection in using a greater tube distance with the Bucky diaphragm?

Answer — It would mean an increase in penetration or time or perhaps both. This not only adds to the strain of the equipment including the tube but also promotes motion on the film.

Question — Should the tube distance be a constant or variable?

Answer — Constant.

EXPOSURE TIME

Question — What does time refer to?

Answer — It means the actual seconds of exposure, often referred to as milliampere seconds (MAS).

Question — How are milliampere seconds determined?
Answer — By multiplying the number of milliamperes used by the actual amount of time in seconds. For example: If 20 milliamperes were used and 10 seconds of time, for any one exposure, the number of milliampere seconds would be 200. If 100 milliamperes were used for 1/10 of a second, the total number of milliampere seconds would be 10.

Question — Why are milliampere seconds determined in X-ray work?
Answer — Because the safety limit in any one exposure is based on a certain figure—1200 for all parts of the body except the head and 900 for the head area.

Question — On what distance is the milliampere second limit based?
Answer — Skin distance. Some authorities claim 15 inches while others claim 18 inches.

Question — What effect will milliampere seconds have on the film referring now to detail?
Answer — With everything else being equal, a lesser amount enables one to do the work quite instantaneously. This tends to eliminate motion on the film. To use a greater amount of milliampere seconds with other factors equal tends to add detail and contrast but promotes motion. This is quite similar to the photographic exposure. Time adds to the sharpness of the outlines and detail.

Question — Is the automatic hand timer advisable?
Answer — Yes, for exposures under a second and a half or when doing comparative work.

Question — What effect will the various machines have on the time factor?
Answer — The greater the capacity of the X-ray machine, the less amount of time in seconds may be satisfactorily used.

Question — Will altering the time factor affect radiographic density?
Answer — With all other factors being equal, the radiographic density varies in direct proportion with the exposure time. Doubling the time doubles the density. Cutting the time in two, halves the radiographic density.

Question — Does the time factor have an effect on distortion?
Answer — No. Time (MAS) should be a constant.

MILLIAMPERES

Question — What are milliamperes?
Answer — Refers to the number of milliamperes used through the tube during the exposure.

Question — How are they measured?
Answer — By a milliammeter.

Question — What is the number of milliamperes used in radiographic work?
Answer — Ordinarily varies from 10 to 100.

Question — Is there a standard number of milliamperes to be used for various exposures?
Answer — No. Some technicians prefer to use a certain number while others may use either a greater or lesser amount.

Question — When is a greater amount ordinarily used?
Answer — In chest work, gall bladder work, in that of children, and in conditions of muscular incoordination.

Question — Will the machine have any effect on the milliamperage?
Answer — Only in so far as the capacity is concerned.

Question — Will the tube have any effect on the milliamperage?
Answer — Only in so far as the capacity of the tube is concerned?

Question — Will the milliamperage have any effect on the distortion?
Answer — No.

Question — What effect will the milliamperes have on density?
Answer — Radiographic density varies in direct proportion to the amount of milliamperes used.

Question — Will milliamperes affect contrast?
Answer — Yes.

Question — How does a greater amount of milliamperes affect the film?
Answer — Other factors remaining equal, the density is decreased or a lesser exposure is needed and vice versa with a lesser amount of milliamperage. Milliamperage is a constant.

PENETRATION (Voltage or Kilo-Volt-Peak)

Question — What is meant by penetration?
Answer — Refers to the voltage supplied by the tube.

Question — What is a kilo-volt?
Answer — 1000 volts.

Question — What is kilo-volt-peak?
Answer — Refers to the highest point or peak of the voltage wave employed.

Question — What does gap or spark gap refer to?
Answer — Another term used in place of voltage.

Question — How is spark gap measured?
Answer — By inches.

Question — Does the voltage factor have any effect on detail?
Answer — No, not materially. It only makes it more or less visible.

Question — How is the voltage to the tube measured?
Answer — By calibration or sphere gap.

Question — What is the usual kilo-volt-peak used in radiographic work?
Answer — Usually ranges from 45 to 100.

Question — Can kilo-volt-peak be fixed to use as a standard?
Answer — No.

Question — When is a lower amount of penetration used in radiographic work?
Answer — For extremities and when an extension of exposure time is used.

Question — Does the voltage have anything to do with distortion?
Answer — No.

Question — When is a greater amount of penetration used in radiographic work?
Answer — When heavy individuals are X-rayed or when instantaneous work is necessary.

Question — Does voltage have any effect on milliamperage?
Answer — No, not particularly.

Voltage, kilo-volt-peak, penetration, or spark gap is a variable.

QUESTIONS AND ANSWERS PERTAINING TO FILM QUALITY

Question — What makes film quality, technically speaking?
Answer — Detail, contrast, density, and minimum of distortion.

Question — What causes distortion?
Answer — The poor alignment of film, tube and patient, the distance of the object from the film, and the tube distance.

Question — What types of distortion are there?
Answer — Two.

Question — What are they?
Answer — Magnification, meaning an increased size of the object on the film, and elongation or an irregular or twisted form of the object, not anatomically true.

Question — Are both types detrimental in film analysis?
Answer — Elongation or the twisted type is detrimental. Magnification may not be.

Question — What is called true distortion?
Answer — Incorrect alignment of tube, object and film.

Question — Can this be eliminated?
Answer — Yes, with proper alignment except for the extremities of the film especially the 14 x 17 and larger films.

Question — What is meant by radiographic detail?
Answer — When outlines are clear, clean-cut and distinct.

Question — What is the primary factor of good detail?
Answer — Part to be X-rayed should be in close proximity to the film.

Question — What is another factor for good detail?
Answer — Fine focal tube.

Question — Will intensifying screens have any effect upon detail?
Answer — Yes. They tend to lose detail.

Question — What causes the screen to tend to lose detail?
Answer — Its speed and size of the screen's crystals. The coarser the grain the more detail is lost.

Question — What important part does the screen play in radiographic work?
Answer — Cuts exposure time, adds materially in producing more contrast, and makes detail plainly visible.

Question — What is meant by radiographic density?
Answer — The film tendency towards a lighter or darker product.

Question — What amount of radiographic density is desirable?
Answer — This seems to be a matter of opinion. For Chiropractic purposes, the lighter film with white sharp outlines and a gray background is the best. For medical purposes both the light and dark films are desirable.

Question — Does penetration have any effect on density?
Answer — Yes, as it increases so does it increase the density and vice versa when the voltage decreases.

QUESTIONS AND ANSWERS PERTAINING TO THE PROTECTION OF THE OPERATOR

Question — What are the principal steps in the protection of the operator?
Answer — To know that his equipment is grounded and can be safely operated so far as shock is concerned.
Operate in a lead-lined booth or room.
Protect by use of lead apron, gloves, goggles, etc. in fluoroscopic work.
Ethical procedures.

Question — How does the lead booth protect the operator?
Answer — It absorbs the rays.

Questions — What rays?
Answer — Secondary.

Question — Should the lead be of any thickness?
Answer — Yes, at least 1/16 inch.

Question — How can the operator observe the patient when operating in a lead-lined booth or room?
Answer — Through leaded glass.

Question — How much lead should be contained in the glass?
Answer — The equivalent of 1/16 inch of virgin sheet lead.

Question — How should a leaded booth be constructed?
Answer — With four sides, top, bottom, one side containing door, a piece of leaded glass sufficiently large to make observation, light (the tubular one is the better to use), and sufficient electrical connections inside to plug in timer or foot switch, Bucky release, and perhaps X-ray switch.

Question — What is the result of too much secondary radiation upon the part of the operator?
Answer — A general run-down condition including dental disturbances, alopecia, etc.

QUESTIONS AND ANSWERS PERTAINING TO THE PATIENT

Question — What is a principal step in protecting the patient?
Answer — Make inquiry to previous X-rays.

Question — What type of ray is harmful to the patient?
Answer — Soft ray.

Question — Why?
Answer — Because they accumulate on the surface of the individual.

Question — How are soft rays produced?
Answer — By using a low gap and extension of time.

Question — How will too many soft rays injure the patient?
Answer — By accumulating on the surface it will burn and destroy tissue, cause the hair to fall, as well as produce the erythema dose.

Question — For what reason are milliampere seconds determined?
Answer — To know when not to over-expose the patient.

Question — What is the limit?
Answer — 1200 milliampere seconds for the body except the head and 900 milliampere seconds for the head area.

Question — How long should the patient wait for other exposures after the limit in milliampere seconds has been given?
Answer — 30 days.

Question — What else adds safety to the patient?
Answer — Using an aluminum filter 1 mm. thick and having all high tension wires insulated or well out of reach.

Question — How does the aluminum filter protect the patient?
Answer — Absorbs most of the soft rays.

Question — How can the high tension wires be insulated?
Answer — By shock proofing the equipment.

Question — What effect will grounding the equipment have on the patient?
Answer — Stops all static electricity.

Question — What is static electricity?
Answer — It is said to be electrical current at rest.

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